SCIENCE

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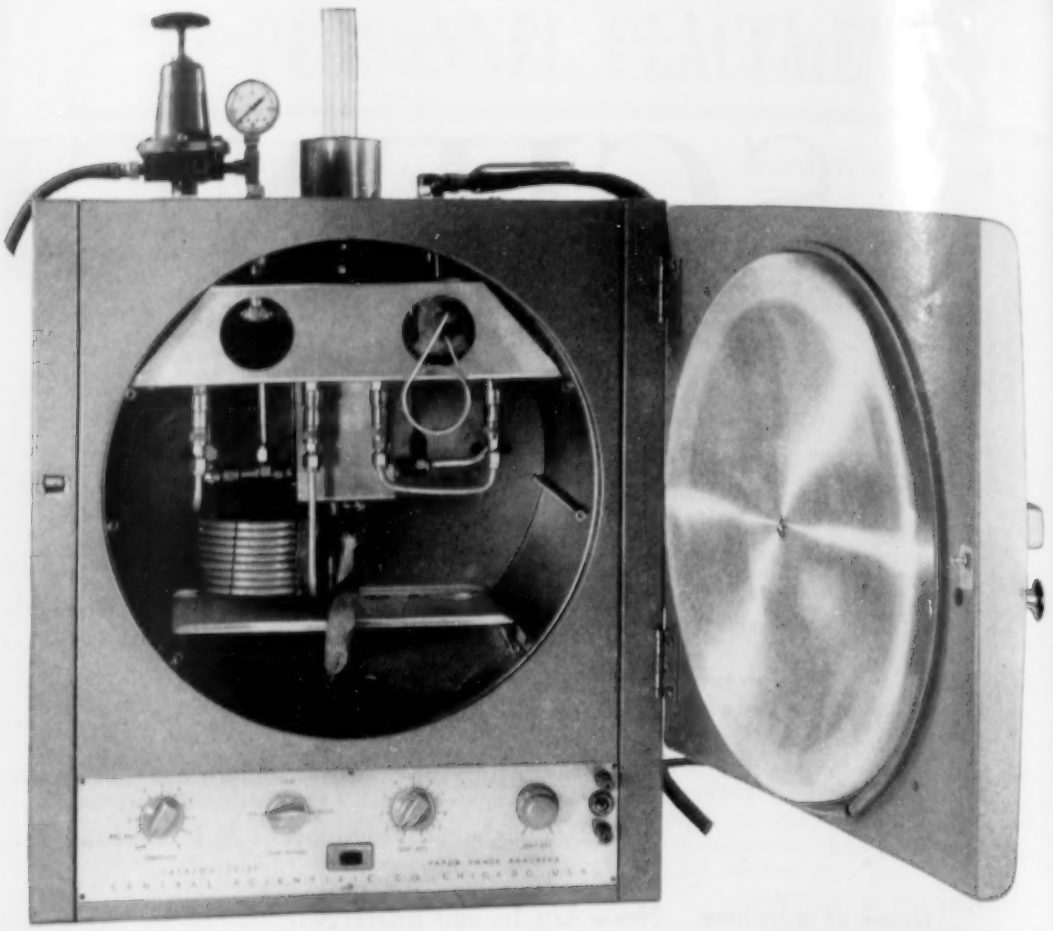

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Communicative Accuracy

The events of the past few months have emphasized something we have known all along—that it is important for scientists to describe their activities to the public in such a way that they will be generally understandable and properly informative. This runs into the practical difficulty that some scientists, when they attempt a "popular" description of their labors and of their ideas, insist on achieving almost the same precision and completeness of statement which they would, quite properly, use in talking to their scientific colleagues. "You must not expect me to say that genes are distributed along a chromosome like different sizes and colors of beads along a string, for I have no satisfactory evidence that genes are as discrete as separate beads, and also I don't know about their sizes and shapes." Such scientists feel the urge to attach to each general statement of a popular exposition all the cautionary qualifications, all the modifying details, and all the scholarly footnotes that they would use in a technical report.

It may be helpful to suggest to such scientists that they consider the concept of "communicative accuracy." This concept rests upon the fact, not always recognized, that the effective accuracy of a written statement depends primarily upon the interpretation given to it by the reader. A statement may be said to have communicative accuracy, relative to a given audience of readers or hearers, if it fulfills two conditions. First, taking into account what the audience does and does not already know, it must take the audience closer to a correct understanding. The better an example of communicative accuracy it is, the more gain in understanding it will achieve—but the basic point is simply that it must gain ground in the right direction. Second, its inaccuracies (as judged at a more sophisticated level) must not mislead, must not be of a sort which will block subsequent and further progress toward the truth. Both of these criteria, moreover, are to be applied from the point of view of the audience, not from the more informed and properly more critical point of view of an expert.

Communicative accuracy is important to all of us all of the time. Consider the illuminating example, recently offered by a newspaper reporter, of the two men coming home from work and greeting their wives. One says, "My dear, when I look into your face, time stands still." The other remarks, "My dear, your face would stop a clock."

WARREN WEAVER

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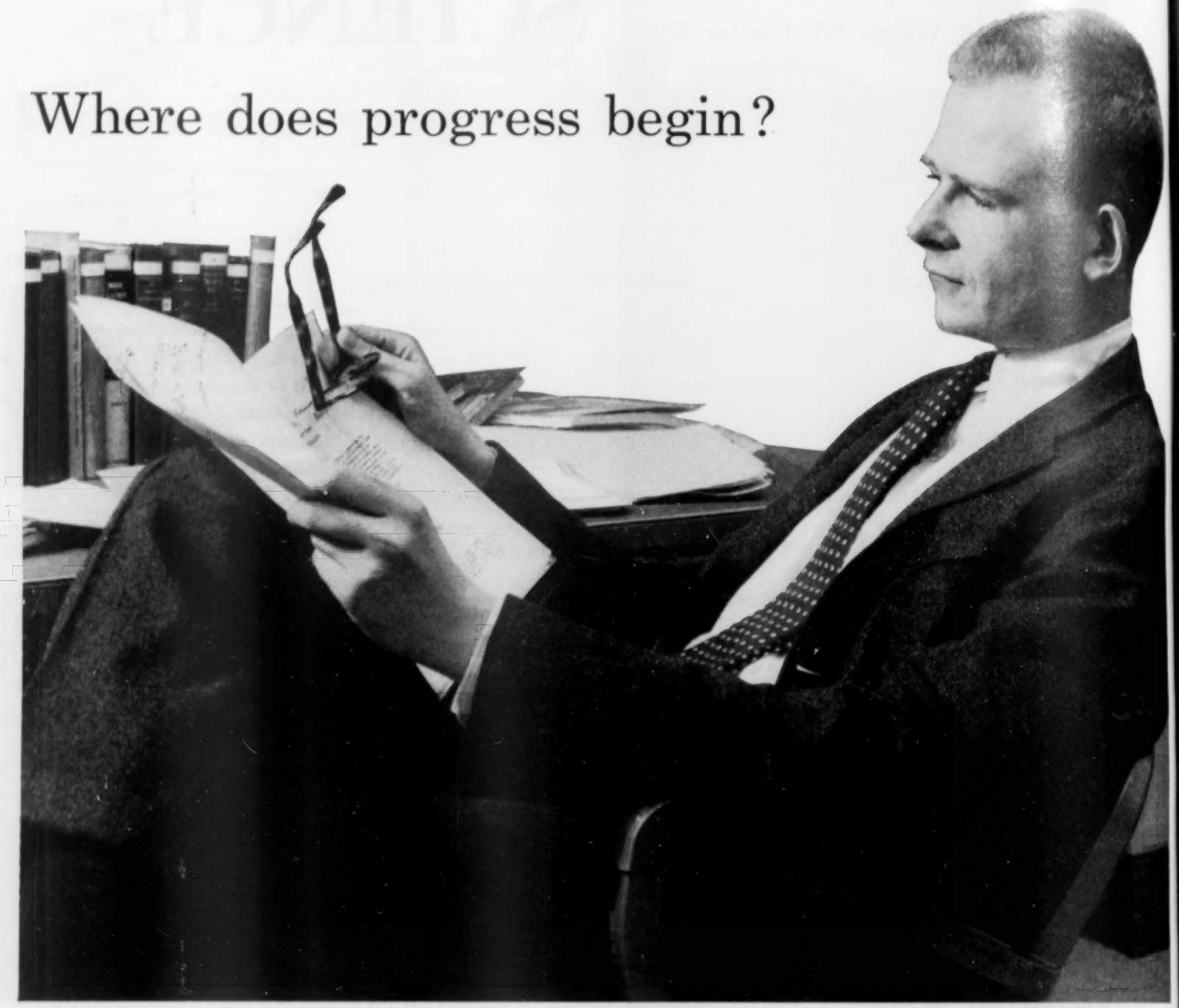

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Distance and Relativity

G. C. McVittie

What does an astronomer mean when he says that the sun and the earth are, on the average, 92,900,000 miles apart? And what bearing can the two theories of relativity have on the matter? It is questions of this kind that I shall try to answer in this article, but I must first warn you that I have been described by my scientific colleagues as an uncompromising empiricist. I daresay that this is true, but it is also a little strange, for all my training and all my research work have lain in theoretical astronomy and not at all in the extremely difficult and fundamental task of making astronomical observations. Perhaps, however, the theoretician does have an advantage over his colleagues who are engaged in observational or experimental work. He can stand slightly to one side and ask himself: What exactly are these men doing, what kind of significance can be attached to the results of their efforts, and in what way are their data really conditioned by theories? To speak in generalities would, I think, be profitless, and it is for this reason that I propose to concentrate on the question of distance in the solar system and to leave aside the equally intricate and fascinating problem of distance in the universe at large.

Large-Scale Distances

It might be thought at first sight that the distance between two objects was such an obvious physical idea that there could be little to say about it. Two marks have been made on a certain bar of platinum that is carefully preserved in France; the separation of the two marks defines the unit of length called the meter. If, then, we want to find the distance from the front door of the J. I. Holcomb Observatory in Indianapolis to the front door of the University of Illinois Observatory in Urbana, all we need do is to lay the meter-bar down successively, starting at the first spot and finishing at the second, and count the number of times we have to repeat the operation. The number so arrived at would give the required distance in meters. But if I were to take any one of you to the Holcomb Observatory, hand you the meter-bar, and tell you to go ahead, I feel sure that you would be at a loss as to how to proceed. You would want to know in what direction to start out, and the specification of a direction means that some angle measured from a standard direction must be furnished. You would also want to know how to allow for the fact that you would at times—admittedly not very often in the flat midwestern plains—be going uphill and at others, down. In other words, how are the accidental errors in the measuring procedure to be dealt with? Again you might ask, if you were of a philosophical turn of mind: Do the two marks on the meter-bar correspond to some immutable degree of separation between them, or is this separation affected by accidental circumstances? Clearly, if in the course of your journey you were forced to pass the meter-bar through the center of a blast furnace in which it was vaporized, you would be hard put to it to know what to do next.

This illustration draws attention to three characteristics of determinations of large-scale distance: that angular measurements are involved, that errors have to be compensated for, and that the persistence of the unit of distance is important. But there are other matters of equal moment. Suppose that we have somehow measured to our satisfaction the distances from the Holcomb Observatory to the University of Illinois Observatory in Urbana and to the Dearborn Observatory in Evanston, respectively. Then is it necessary to repeat the measuring operation between the two last-named observatories in order to find the distance between them? The answer is, unfortunately, yes, if we do not know the geometry of the surface on which these three points lie. But if we do know it, then the rules of the geometry will enable us to calculate the required distance without further appeal to measurements. Conversely, measurements of distances between a sufficient number of points will give us a clue to the geometry that must be used to describe the interrelationships between the distances and the angles that are necessarily involved in them. With geometry, mathematical theory enters into our distance computations and, unfortunately for those who like their science to be simple, there is more than one kind of geometry. For example, the ordinary plane geometry of Euclid that we learn at school is different from the geometry on the surface of a sphere that surveyors use when they are making a survey of the United States. By this I mean that the mathematical formulae that are employed for interrelating distances and angles in the one case are not the same as those used in the other.

If you feel dismayed by the complexity of these problems, I shall now increase your dismay by introducing some further factors that are of the greatest importance in astronomy. The three observatories I have referred to are, to the best of our knowledge and belief, at mutual relative rest, their distances apart remaining unchanged as time goes on. This very simple situation almost never

Dr. McVittie is the head of the University of Illinois Observatory, Urbana. This article is adapted from a paper presented 26 December 1957 at the Indianapolis meeting of the AAAS.

arises in astronomy, nearly every astronomical object being in motion relative to ourselves on earth. Clearly, a distance determination for a moving object is meaningless unless we are also told the time to which the determination refers. Thus, two more elements are involved when the distances of moving objects are concerned—that is, we must know what is meant by the time of occurrence of an event and we must also know how the motions of bodies are governed, what the theories of dynamics and of gravitation may be.

But even if these complications have been allowed for, there is an additional one that enters into distance determinations in astronomy. Up to the present, it has not proved possible for an astronomer to leave the earth and go to any of the bodies whose distances he would like to find. In this respect, he differs from the terrestrial surveyor who can, at a pinch, actually proceed from one point to another on the earth's surface. The astronomer has to rely almost entirely for his knowledge of the astronomical universe on the information conveyed to him through the medium of electromagnetic radiation, whether in the form of optically visible light or in that of radio waves. The behavior of electromagnetic radiation in the astronomical universe is partly determined by experimental evidence in the laboratory but also very largely by a liberal use of theory. In the application to the solar-system distance problem, it can be established experimentally on the terrestrial laboratory scale that light rays travel in straight lines in Euclid's sense of this term. The belief that this is a property of all electromagnetic radiation and that it continues to hold as the radiation travels over the vast spaces between astronomical objects is based on theory, and a theory is something which is constructed by the human mind and which therefore need not enshrine some everlasting truth. When we come to discuss the phenomenon of the bending of light rays, we shall see that this laboratory conclusion about the nature of the paths of light rays cannot always be sustained.

Distance in the Solar System

After this brief survey of the main difficulties of principle that confront the astronomer when he tries to determine the distances of the objects in which he is interested, let us examine the procedures that he in fact employs. The famous astronomer Johannes Kepler, who lived from 1571 to 1630, showed how it was possible to set up a scale model of the solar system without having any accurate notion of the distances involved in terms of miles or kilometers. Suppose that Kepler came back to earth today and that we carefully concealed from him all the accumulated astronomical knowledge of the past 327 years. But suppose that we showed him how to work our modern telescopes and clocks and then suggested that he go ahead and, with this greatly improved instrumentation, repeat the investigations that made him famous. Kepler would no doubt begin by measuring, each day, the angular diameter of the sun. By methods which would be familiar to him, even if they are not to all of us today, he would, by measuring certain other angles at noon each day, determine the sun's position relative to the background of the stars. Note the important point that his observations consist entirely of measuring *angles* and not at all of measuring *distances*.

The changes in the angular diameter of the sun from day to day he would interpret by saying that it was the (unknown) distance of the earth from the sun that was varying; the apparent motion of the sun relative to the distant stars, sometimes faster and sometimes slower during the course of the year, would eventually lead him to the conclusion that the earth was moving round the sun in an ellipse, with the sun in one focus. He would draw on a piece of paper an accurate reproduction of this ellipse, with all the distances relatively correct but with not one of them known in terms of miles or kilometers. Having completed this operation he would take each planet in turn and, again observing angles only, find that each planet moved in an ellipse with the sun in one focus, the reproduction of each ellipse being on the same scale as that used for the earth's orbit.

But in all this there is one point of theory that would seem self-evident to Kepler, though it would not be so to a modern mathematician looking over his work. He would take it for granted that the interrelations between the angles he was measuring and the distances involved were those of Euclidean geometry and that, moreover, the light rays reaching him from the objects he was studying traveled along Euclidean straight lines. To this day astronomers, in dealing with the solar system, make, for most purposes, the some geometrical assumptions that Kepler did. And they express the distances in terms of the astronomical unit of distance, which is nearly, though not quite, the same as the earth's mean distance from the sun.

Turning the astronomical unit into miles or kilometers is a separate problem. Since a scale model of the solar system is at our disposal, all that is required is the measurement of one distance in the system in order to fix the scale. To obtain this, the earth must first be surveyed and the distances between astronomical observatories must be determined. The base lines from which the survey starts are measured, not with the standard meter-bar, but with flexible metal tapes stretched to a given tension, and the belief that a consistent system of distance relations between points on the earth's surface can be established on such a basis depends on a good deal of theory. There must be a theory of the nature of a metal and theories of dynamics and of elasticity—here the classical Newtonian theories are employed—before the surveyors can be sure that using the metal tapes in the way they do is likely to provide an internally self-consistent network of distances. It is also taken for granted that the geometry which interrelates the measurements is the Euclidean, the surface of the earth being regarded as a mathematical surface in a three-dimensional Euclidean space.

Suppose then, that the Euclidean straight-line distance between two widely separated observatories A and B has been thus established, partly by measurements and partly by geometrical calculation. A planet P having been selected, the angles between the lines AP and AB and between BP and AB are observed simultaneously at A and B. Again by means of Euclidean geometry, the distances from A and B to the planet can be calculated and the scale of the solar system determined. In all this procedure, the important elements of principle are: firstly, that all measurements are angular measurements, except for the distances between the ends of the base lines on earth that are established by use of flexible metal tapes; secondly, that calculations are performed through the formulae of Euclidean geometry; thirdly, that the paths of light rays are straight lines in the Euclidean sense; and fourthly, that it must be possible to attach a meaning to the statement that two widely separated events are simultaneous, the two events in question being the observations of the planet from the observatories A and B.

Time and Distance

It is not only by way of this question of simultaneity that time has reared its ugly head; our resurrected Kepler had already tacitly incorporated the notion of time intervals into his scale model of the solar system through his procedure of making observations on successive *days* and in successive *years*. He must have known what a day was and what a year was before he could act in the way he did. And, indeed, the astronomers of today introduce the notion of time into distance computations in the solar system in a much more indirect and yet fundamental way. They have at their disposal all the dynamical theory and the theory of gravitation which were first invented by Isaac Newton in the second half of the 17th century and whose detailed consequences have engaged the attention of mathematical astronomers ever since. As G. M. Clemence (*1*) has pointed out, the unit of time employed in these theories is the average value of the mean solar day during the 18th and 19th centuries, and the astronomical unit of distance is defined as the theoretically predicted radius of the circular orbit around the sun of a planet of very small mass moving at an angular rate, expressed by a fraction given to 11 places of decimals. Now the Newtonian theory of planetary motion contains two very important principles which underlie the three laws of motion. These are, firstly, the postulate that all angular and distance measurements in the universe can be manipulated by the rules of Euclidean geometry and, secondly, that there exists an absolute time. The absolute time is pragmatically defined with reference to the mean solar day during the two centuries referred to, and it is one of the merits of the Newtonian theory that distance measurements and time measurements can be manipulated separately—the first, as I have said, by the rules of Euclidean geometry; the second, on the principle that time is a scalar and that time intervals are not affected by the geometry that is being employed for distances.

I would like to put forward here the view that astronomers are not engaged in discovering eternal truths about the dimensions of the solar system relative to the selected base lines on earth, or even relative to an unknown mean distance of the earth from the sun. They are not even achieving approximations to these truths within some limit of experimental error. In my opinion, the combination of measurements, geometrical argument, and dynamical theory serves to establish an internally self-consistent scheme of distance relationships with which time relations are inextricably intermingled. The magnitudes of the errors do not measure the departure of the scheme from some ideal eternal truth laid up in heaven; rather do they establish a measure of the degree of self-consistency. The adequacy of the scheme can be tested by using it to make predictions of future events—for example, to predict in what part of the sky the planet Mars will be at some date in the future. The prediction can eventually be checked by observation, and this observation in turn will be incorporated into the scheme and will modify it. That the modification may be very slight is irrelevant; its acceptance by astronomers as a natural corollary of their work is the interesting point.

Special Relativity

You will be wondering by this time why I included in my title the subject of relativity, since I have so far made no reference to this theory. The reason is that, in my opinion, the theories of special and general relativity cannot be discussed *in vacuo* but must be envisaged in some context of observational data. You will remember that special relativity owed a good part of its origin to the Michelson-Morley experiment, which was intended to measure the velocity of the earth in its orbit by a purely optical experiment performed in a laboratory from which no celestial object could be observed. The expectation of success depended on calculations based on the principles of the Newtonian theory of motion applied both to the motion of the earth and to the motion of light. The experiment revealed that the expectation was unjustified—that the orbital speed of the earth could not be measured in this way and that this was not due to errors of observation but was a genuine null result.

The special relativity interpretation of this conclusion idealized the situation to the extent that the effect of gravitation was omitted and the earth was regarded as moving in a Euclidean straight line, with constant speed, during the very short time interval occupied by the experiment. It was then shown, firstly, that the hypothesis of the validity of Euclidean geometry could be retained but that, secondly, the assumption of a single absolute time would have to be rejected. On the basis of these two postulates, a new theory of motion could be worked out from which the null result of the Michelson-Morley experiment could be predicted. More precisely, if there are two frames of reference for distance measurements, distances in each being established by identical procedures, and if the frames of reference are in constant relative motion as judged from either frame, then to each frame there must be associated a system of timekeeping of such a kind that the velocity of light has the same value relative to either frame.

The important points that are brought out by special relativity are, firstly, that there is no absolute theory of motion and of the associated dynamics; secondly, that time and distance measurements can be much more closely interwoven than they are in the Newtonian theory of motion; and thirdly, that as a result of this closer interweaving, two events can be simultaneous in one frame of reference but not in another and, concomitantly, that the distance between two events is not an absolute but depends on the frame of reference relative to which it is measured. The device that is employed in relativity theory for interlocking closely time and distance measurements is to use what may be called a four-dimensional geometrical representation for all the events under contemplation. Each event is "plotted," so to speak, as a "point" having four, instead of the usual three, coordinates; three of these fix the position in space of the event relative to some frame of reference, the fourth is a coordinate specifying the instant of occurrence of the event in the same frame of reference.

My own personal view of this procedure is that a geometrical manifold used for such a representation is a mathematical device that is very valuable for purposes of calculation, but I am not convinced that it is anything more than this. A convenient name for the four-dimensional manifold is "space-time," but as for its "reality" or its "physical existence," I would not like to commit myself because I do not know what these terms mean. What I do know, as a theoretician, is that I can make calculations and predict the circumstances of the motions of bodies by using the mathematical technique of the space-time representation.

Let us return to the astronomers in the observatories *A* and *B* who are engaged in determining the distance of the planet *P*. You will remember that an

essential part of the procedure was that their observations had, in principle, to be made at the same instant. But this simultaneity is now dependent on the selection of one of the reference frames of special relativity; there is no absolute definition available. Nor is there any absolute definition of the distance between the two observatories. We might think that we could select the frame of reference relative to which A and B were at rest, which I will call the zero frame, and assume that the time associated with the zero frame was the time kept by the observatory clocks. But if we imagine a second frame of reference moving with uniform speed u with respect to the zero frame, then, in terms of the time appropriate to this new frame, the astronomers at A and at B would not be carrying out their observations simultaneously and the distance from A to B would have a value that differed from that in the zero frame. This difference would depend on the ratio of the square of u to the square of the velocity of light, c.

Now it might be thought that we could eliminate these difficulties by simply asserting that the zero frame had priority over all the other possible ones, but this cutting of the Gordian knot will not do, for there is another principle inherent in relativity theory to which I have not yet referred. It is this: Reference frames, even of the combined space and time variety used in relativity, are elements introduced into the description of the physical situation by the investigator and are therefore alterable at will. Nothing essential must therefore be made to depend on the choice of one reference frame rather than another; all reference frames must be on an equal footing, and we should fix attention on those conclusions that can be demonstrated to be equally valid in every reference frame. It happens that the numerical value of a distance between two events is not an invariant quantity in special relativity but depends on the selected reference frame, and the same applies to the time interval between any pair of events. This is not to say that measures of distances and of time intervals are valueless but that the conditions of measurement must be carefully stated and the relativity of the results must be firmly kept in mind.

If you have followed me so far, you will no doubt have noticed that there is an apparent contradiction between what I have just said about special relativity and what I said earlier about the procedure actually employed by astronomers in establishing distances in the solar system. I have emphasized that, in doing so, these scientists take it for granted that distance is an absolute in the Euclidean sense and that time is also an absolute in the sense of Newtonian dynamical theory.

Since astronomers are acquainted with special relativity, why do they continue to act as if they were not? The answer is that the differences inherent in the use of one frame of reference rather than another depend on the ratio of the square of the relative velocity of the frames to the square of the velocity of light. Now the velocity of light is 186,000 miles per second, and the relative velocities of objects in the solar system rarely attain, say, 70 miles per second. Thus, the ratio of the squares of these velocities will be found to introduce changes in the distances that amount at most to one part in ten million. But the astronomical unit of distance is determined to within the very much larger error of one part in five thousand. Thus, if this is the kind of accuracy we are working to, or, as I would prefer to put it, if this is the measure of the internal self-consistency we aim at, special relativity can be disregarded in direct calculations of distances. But it is not self-evident that the effects of relative velocity on our distance and time computations may not give rise to observable differences from the predictions of Newtonian theory when these effects can be shown to be cumulative in time. To consider this type of question we must pass on to general relativity.

General Relativity and the Solar System

Expositions of general relativity very often give the impression that the only difference between this theory and special relativity lies in the character of the relative motion of the "time and space" frames of reference employed. Whereas in special relativity the frames are in uniform relative motion, in general relativity mutually accelerated frames are considered. This is certainly one aspect of general relativity, but, by itself, the introduction of mutually accelerated frames is not sufficient. The essence of the difference between the two theories is more subtle; it lies in a change of character of the four-dimensional geometrical representation of the events under contemplation. Whereas in special relativity this representation has the geometrical characteristic known technically as "flatness," in general relativity the representations are "curved."

It is not easy to explain this essential difference to nonmathematicians, especially as the terms *flat* and *curved* have so many connotations that their very use in this technical connection is misleading. One can but try to use an analogy drawn from geometrical manifolds of two, instead of four, dimensions. The Euclidean plane is one such two-dimensional manifold, the surface of a sphere is another; the former possesses the geometrical attribute of flatness, the latter, that of curvature.

This difference manifests itself in the geometries appropriate to the two surfaces. Thus, in the Euclidean plane, straight lines are of infinite length, the three angles of a triangle have a sum equal to π, the sum of the squares of the two sides of a right-angled triangle is equal to the square of the hypotenuse, and so on. On the surface of a sphere, great circles are the analogs of straight lines, and they are of finite length; the angles of a spherical triangle do not have a sum equal to π; and Pythagoras' theorem in the form I have stated it is no longer true.

The four-dimensional space-times of general relativity differ from one another and from that employed in special relativity in analogous but far more complicated ways. This is not only because four, as against two, dimensions give rise to greater intricacy but also because one of the dimensions is interpreted physically as referring to the time relations between events. The time and distance measurements made by astronomers are thus interwoven in a more elaborate way than they are in special relativity, and they lead to a new theory of motion and of dynamics. In general relativity it is postulated that each physical situation has its own appropriate space-time, the connection between the two being made through Einstein's gravitational equations. Moreover, the only effects that are taken into account are those of relative velocity (as in special relativity), gravitational attractions, and a peculiar force which is either one of repulsion or of attraction, according as the so-called cosmical constant is a positive or negative number. The physical situation, consisting of a very massive sun around which move planets of relatively infinitesimal mass, has one space-time representation; the whole astronomical universe of galaxies has another, with quite different properties of

curvature. Thus, once again, I would regard these space-times as devices for calculation purposes, rather than as entities having any kind of "physical existence."

But to return to our astronomers studying the solar system. The space-time representation appropriate to this physical situation was worked out almost immediately after Einstein had propounded, in 1917, the general theory of relativity. The geometry of space, by which the relations between the angles and distances that the astronomers measure are calculated, can be shown to be so nearly Euclidean that this classical geometry can be safely employed for most purposes. Similarly, there is a kind of time appropriate to the physical situation which possesses nearly, but not quite, the properties of absolute Newtonian time.

But do not let us be hasty and jump to the conclusion that, if the departures from the Newtonian theories of dynamics and gravitation are so small, we can dispense with general relativity. For these departures can have cumulative effects when we are concerned with predicting how a body in the solar system will move. Observations of the planet Mercury, which has an orbit lying fairly close to the sun, where the gravitational field is strongest, and which also moves with a relatively high orbital speed, had revealed, long before the advent of general relativity, an unexplained motion in space of the planet's point of closest approach to the sun. The amount of this motion was some 43 seconds of arc per terrestrial century, and it was found that general relativity could interpret it in terms of the mass of the sun and the dimensions of the orbit of Mercury.

You might be interested to know what the corresponding figure for an artificial satellite of the earth would be. Let us suppose that the earth is perfectly spherical—which it is not—and that the maximum and minimum distances of the satellite from the surface of the earth are 200 and 600 miles, respectively; and let us ignore the frictional resistance of the earth's atmosphere. Then the point of closest approach of the satellite's orbit would move in space through 1324 seconds of arc in a century. The figure is large compared with that for Mercury in spite of the fact that the earth's gravitational field is incomparably weaker than the sun's and that the satellite's average speed in its orbit is only about one-sixth of Mercury's. The cumulative gain lies in the number of revolutions: in 100 years Mercury goes round the sun about 414 times, whereas in the same period the satellite would circumnavigate the earth nearly 540,000 times.

But to return to the sun. Another striking effect of the non-Euclidean character of the space-time appropriate to the solar system is the phenomenon of the bending of light rays. When the stars beyond the sun are photographed during a total solar eclipse and when the picture is compared with one taken at night, it is observed that the stars appear to be relatively further apart in the eclipse picture than in the other. An effect of this kind is predicted by general relativity, because the paths of light rays in the space-time can be regarded as Euclidean straight lines only in regions remote from the sun, where its gravitational effect is weak. Near the sun itself the geometry departs sufficiently from the Euclidean to give an observable difference. The theoretical prediction is that the distortion of position for a star seen at grazing incidence beyond the sun's disc would be 1.75 seconds of arc. As far as I am able to judge from the results of observations made during six total eclipses since 1919, this figure corresponds to that found from observation.

Conclusions

Let me now try to summarize, in conclusion. Distance determinations in the solar system have always, in the main, consisted of the measurements of angles and of time intervals. Determinations of the positions occupied by a celestial body at successive instants of time have necessarily involved some theory of dynamics and of gravitation. The theories of relativity have shown that time measurements can be interconnected with the distances deduced from the angular measurements in a more intimate way than that postulated by Newton. This has had as a consequence the development of dynamical and gravitational theories different from his. In addition, each physical situation has its own system of time and distance interconnections, obtained through the mathematical device of four-dimensional geometrical representations in which time is regarded as a fourth coordinate interwoven with the three spatial coordinates. General relativity has achieved an interpretation of phenomena in the motions of the planets and of light which had escaped the Newtonian net. I wish I had the space to explain, and that you had the endurance required to absorb, the further applications of these ideas to the universe at large, where distances are measured in millions of light-years instead of in millions of miles.

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The Search for Anticancer Antibiotics

Some Theoretical Problems

G. F. Gause

Although the empirical approach is inevitable in the search for anticancer antibiotics, the efficiency of the screening increases when one combines empiricism with the theoretical analysis of specific metabolic differences between normal and malignant cells and utilizes these differences for the detection of substances that selectively inhibit those aspects of metabolism which are peculiar to the cancer cell.

As is well known, much work still remains to be done by the biochemists on the analysis of the specific metabolic differences between normal and malignant cells. It seems likely, however, that hereditary injury of the respiratory system of the cancer cell is one of the established characteristics of malignant growth. This impairment was first observed by Warburg about thirty years ago and, in spite of some criticism, has been entirely substantiated by more recent studies (*1*, *2*). Measurements of the metabolism of malignant human cells show that hereditary deficiency of respiration is sometimes accompanied by a hereditary decrease, and sometimes by an increase, of aerobic glycolysis in the various strains of cancer cells (*3*).

It is to be recalled that alterations of metabolism peculiar to malignant growth can take place in cells of various living organisms. Julian Huxley was right in his recent generalizations (*4*) that "cancer is not merely a medical problem; it is a biological phenomenon, whose elucidation is bound up with advances in a number of key fields of present-day biology. . . . Neoplastic tumours are widespread in the organic realm."

The author is professor in the Institute for Antibiotic Research of the Academy of Medical Sciences of the U.S.S.R., Moscow. This article is based on a paper presented in New York on 21 Nov. 1957 at the Pasteur Fermentation Centennial sponsored by Chas. Pfizer & Co., Inc.

If Huxley is correct, could one not obtain some equivalents of cancer cells in microbiology? That is, could one not obtain biochemical mutants of microorganisms with hereditary impairment of their respiratory system and, most important of all, utilize these mutants as tests in screening for antibiotics that selectively inhibit malignant growth?

Microorganisms with Injured Oxidation

Some studies in this direction have been recently made in the Institute for Antibiotic Research of the Academy of Medical Sciences in Moscow. The first stage of investigations consisted in the production of biochemical mutants of microorganisms with injured oxidation. Gause, Kochetkova, and Vladimirova (*5*) used for this work yeast cells, *Saccharomyces cerevisiae* strain AN-2. Under the action of trypaflavine, which, according to Ephrussi and his collaborators (*6*), induces in yeast mutations with a deficient cytochrome system, we obtained six different mutant strains. The data on the respiration and aerobic glycolysis of these strains are given in Table 1. In all six mutant strains studied by us there was a strong hereditary injury of the respiration; the oxygen consumption in various mutant strains was decreased to 1/10 to 1/200 of that of the parent cells. It is interesting to record in this connection that, in some mutants, the injury to respiration was accompanied by an increase of aerobic glycolysis (strains 7, 22, and 25); in others, aerobic glycolysis was only slightly enhanced (strains 11 and 26); and finally, in one of the mutant cultures (No. 33), the aerobic glycolysis was decreased as compared with the value characteristic for the parent culture. In other words, in biochemical mutants of yeast with impaired oxidation, aerobic glycolysis can change in different directions, in the same way as it was observed in studies of aerobic glycolysis of malignant cells belonging to different strains. It is only now, one hundred years since Pasteur began his work in this important field, that we come to the understanding that in biochemical mutants, aerobic glycolysis can change independently of alteration in the respiratory system.

Furthermore, we obtained mutant strains of yeast with injured respiration under the action of ultraviolet radiation and of camphor; the latter, according to Bauch (*7*), possesses strong mutagenic action upon yeasts. The data on the respiration and aerobic glycolysis of these strains are presented in Table 1.

For the rapid detection of the biochemical mutants of yeast cells with deficient oxidation, we worked out a specific method of staining their colonies, enabling us to distinguish by color the colonies of mutants from those of the normal cells. The leucobase of methylene blue was used for this purpose. Roskin (*8*) observed that normal human cells rapidly oxidize the colorless leucobase and stain themselves with deep blue color, whereas cancer cells under the same conditions of experiment remain colorless because of their deficiency in respiration. We observed that this principle of differential staining can be employed for diagnostic purposes to detect the biochemical mutants of yeast cells with impaired respiration, if the leucobase of methylene blue is added to the beer-wort agar media before the latter is poured into the petri dishes. The growing colonies of normal yeasts acquire deep blue color, whereas the colonies of mutants remain colorless, to the extent that they are unable to oxidize leucobase into methylene blue because of the deficiency of their respiratory system.

Besides yeast cells, Gause, Kochetkova, and Vladimirova (*9*) also used staphylococci for producing biochemical mutants with deficient respiration. The staphylococci turned out to be particularly useful as tests for the detection of substances possessing selective inhibitory action upon cells with an impaired respiratory system. Under the action of ultraviolet radiation of *Staphylococcus aureus* strain 209, we obtained three mutant cultures, Nos. 1, 2, and 3, which differed from the original parent strain by the small size of their colonies, by a de-

creased growth rate, and by a hereditary deficiency of respiration, as is shown by the data presented in Table 2. Table 2 shows that, in different strains of mutant staphylococci, the consumption of oxygen decreases to 40 to 65 percent of that of the parent culture. The decrease of oxygen consumption in the biochemical mutants of staphylococci is not as great as it is in the biochemical mutants of yeasts, in which oxidation, as is shown by the data of Table 1, may sometimes decrease to 1/200 of that of the parent culture—that is, it is practically excluded under aerobic conditions. As is well known, the consumption of oxygen in cancer cells may often decrease to half of the value characteristic for normal cells. In other words, the impairment of the respiratory system of cancer cells is quantitatively more like that of biochemical mutants of staphylococci than it is like the respiratory deficiency in the mutant strains of yeasts.

Some biochemical differences between mutant strains of staphylococci Nos. 1, 2, and 3 will not be considered at present. Let me only note that the respiration of all these mutant strains is much less sensitive to cyanide than is the respiration of the parent culture. This fact points to a deficiency of the cytochrome system as a cause of impaired respiration in the mutant strains.

Use of Mutants for Testing

Having outlined briefly some characteristics of the biochemical mutants of yeast and staphylococci with impaired respiration which have been obtained by us, we can now pass on to what seems to be the essential part of the investigation —namely, the use of these mutants as tests in screening for antibiotics that selectively inhibit cells with impaired respiratory systems. For this purpose, 2500 different cultures of actinomycetes freshly isolated from various soils were streaked upon nutritive agar in petri dishes, and after 48 hours of growth at 28°C they were cross-streaked by suspensions of different microorganisms, including parent cultures and mutant strains of staphylococci and yeast cells. According to the data obtained by T. P. Preobrazhenskaia and E. S. Kudrina (*10*), 53 cultures (that is, about 2 percent) possessed selective inhibitory action upon the biochemical mutants of staphylococci with impaired oxidation. These cultures did not inhibit the growth of

Table 1. Respiration and aerobic glycolysis in biochemical mutants of *Saccharomyces cerevisiae* with impaired oxidation (from Gause, Kochetkova and Vladimirova, *5*). Q_{O_2} shows the consumption of oxygen in cubic millimeters per hour, and Q_{CO_2} gives the production of carbon dioxide in cubic millimeters per hour, calculated for 1 milligram of the dry weight of yeast.

Culture	Respiration		Aerobic glycolysis	
	Number of experiments	Q_{O_2}	Number of experiments	Q_{CO_2}
Control (parent)	19	41.8	24	326.0
Trypaflavine 7	4	4.2	6	427.0
Trypaflavine 11	4	5.1	4	388.0
Trypaflavine 22	4	0.2	6	414.0
Trypaflavine 25	4	0.2	4	411.7
Trypaflavine 33	4	6.0	4	282.0
Trypaflavine 26	4	5.2	4	360.5
Camphor 27	4	4.2	2	339.3
Camphor 4	4	3.5	2	386.0
Camphor 23	4	10.5	4	353.0
Camphor 2	4	10.9	4	410.0
Ultraviolet 10	8	2.9	8	321.0

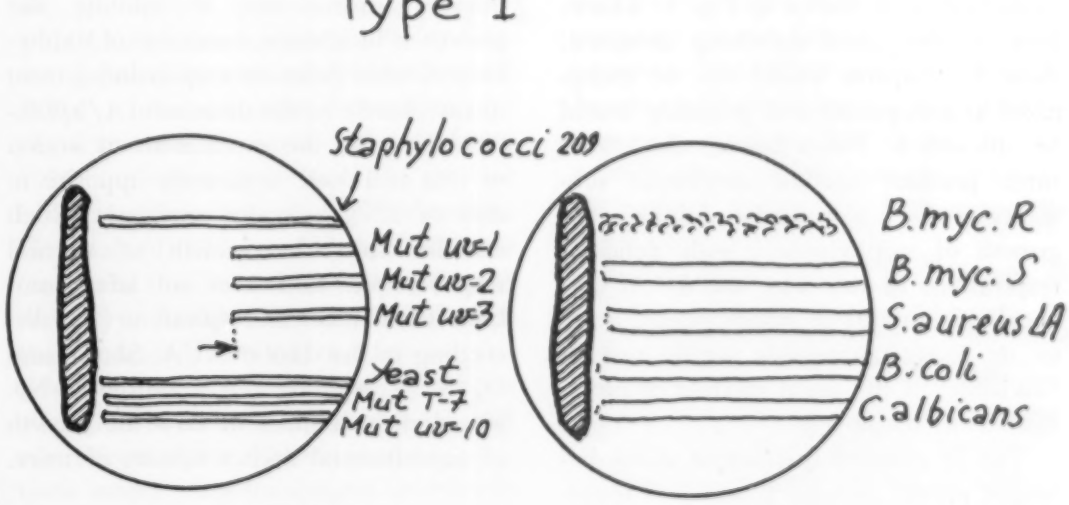

Fig. 1. Selective inhibitory action of a culture of actinomycete upon mutant staphylococci with impaired oxidation.

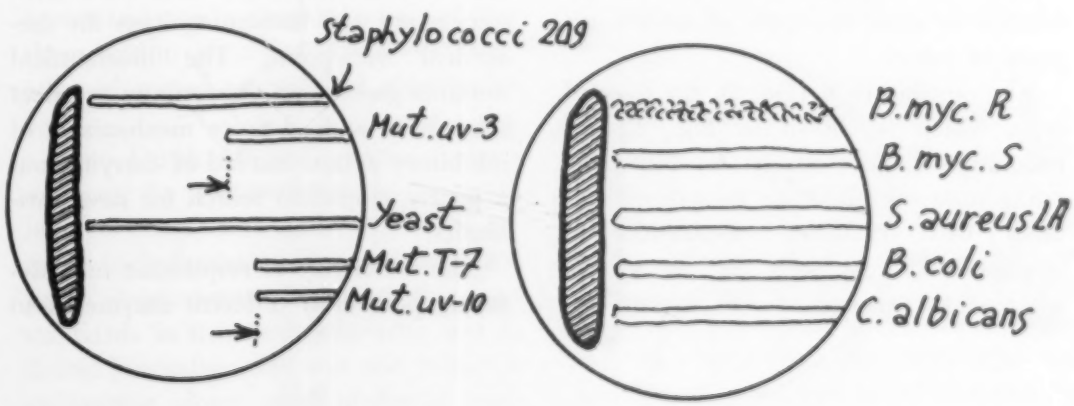

Fig. 2. Selective inhibitory action of a culture of actinomycete upon mutant strains of staphylococci and of yeast cells with impaired oxidation.

Table 2. Respiration in biochemical mutants of *Staphylococcus aureus* 209 with impaired oxidation (from Gause, Kochetkova and Vladimirova, *9*). Q_{O_2} shows the consumption of oxygen in cubic millimeters per hour calculated for 1 milligram of the dry weight of bacteria.

Culture	Number of experiments	Q_{O_2}
First series		
Control (parent)	10	95.2
Ultraviolet-1	4	65.0
Ultraviolet-2	8	49.5
Ultraviolet-3	4	44.0
Second series		
Control (parent)	10	104.5
Ultraviolet-1	6	64.5
Ultraviolet-2	6	51.7
Ultraviolet-3	6	41.3

normal staphylococci belonging to different strains, nor did they inhibit the growth of the other test microorganisms employed, as is shown in Fig. 1. Therefore, in the usual screening program, these 53 cultures would not be recognized as antagonists and probably would be discarded. Nevertheless, these cultures produce specific antibiotic substances that selectively inhibit the growth of staphylococci with deficient respiration. In this way, the use of biochemical mutants of staphylococci helps us to detect antibiotics which remain "invisible" if the usual method of investigation is employed.

The 53 cultures mentioned above belonged mostly to type 1, which is represented in Fig. 1 These cultures selectively inhibited the growth of only mutant strains of staphylococci with impaired respiration; they were not active against normal staphylococci, yeast mutants, or the other microorganisms employed. Ten of these cultures produced chemical substances which not only inhibited the growth of biochemical mutants of staphylococci but also inhibited in vitro the cells of ascites tumors of mice.

The antibiotic action of the second type, which is shown in Fig. 2, was encountered more rarely. In this case, antagonists inhibited the growth of mutants with deficient respiration in staphylococci as well as in yeasts, whereas the growth of the parent cultures and of the other microorganisms was not affected. We observed only eight antagonists of this type; among these, six cultures inhibited in vitro the cells of ascites tumors of mice.

Some cultures of actinomycetes which selectively inhibit, in petri dishes, the growth of biochemical mutants of microorganisms with deficient respiration, possess also the capacity to produce selectively inhibiting substances in the course of their submerged growth in liquid nutritive media. The isolation of the active substances and the study of their chemical nature are of great interest.

From cultures of various actinomycetes, M. G. Brazhnikova, T. A. Uspenskaia, and I. N. Kovsharova (*11*) isolated chemical substances that possessed selective inhibitory action upon the biochemical mutants of staphylococci with deficient respiration. One of these, antibiotic No. 992, was obtained in crystalline form. This substance is inactive toward normal staphylococci and other microorganisms, but it inhibits the growth of biochemical mutants of staphylococci with deficient respiration (strain ultraviolet-3) in the dilution of 1/5,000,000. That is, the mechanism of action of this antibiotic is directly opposite to that of albomycin, an antibiotic which inhibits only the growth of normal staphylococci and does not affect mutants with deficient respiration (*9*). According to the data of V. A. Shorin and O. K. Rossolimo (*12*), antibiotic No. 992 slightly inhibits in vivo the growth of experimental ascites tumors of mice.

Conclusion

It is too early to say at present whether the chemical substances that selectively inhibit the growth of biochemical mutants of microorganisms might acquire some practical importance in the future for the treatment of malignant growth. But it is already clear that these substances are very interesting from the theoretical viewpoint. The biochemical mutants give us an opportunity to select substances with definite mechanisms of inhibitory action instead of carrying out a purely empirical search for new antibiotics.

The deficiency of respiration may depend upon many different enzymes, and it should be subjected to special analysis. It was found, for example, that mutant strains of staphylococci with deficient respiration (ultraviolet-2 and ultraviolet-3) are not identical. In strain ultraviolet-3 the respiration is more strongly injured and is less sensitive to cyanides than it is in strain ultraviolet-2. We observed antibiotics which did not inhibit the growth of common microorganisms and were at the same time active only against mutants of ultraviolet-2, but not against mutants of ultraviolet-3. In this way the biochemical mutants of microorganisms give us an opportunity to detect "invisible" antibiotic substances, selectively inhibiting some specific biochemical systems of the living cell. It seems probable that further work along these lines may stimulate closer cooperation between those conducting screening programs for antibiotics and biochemists; such cooperation might be helpful in the design of screening programs.

In summary, we can say that, in screening for new anticancer antibiotics, the two following generalizations may be helpful. (i) There is a possibility of obtaining the equivalents of cancer cells in microbiology—that is, biochemical mutants of microorganisms with deficient respiration and probably with some other alterations in cell metabolism which are specific for malignant growth. (ii) There is a possibility of using these biochemical mutants for the detection of new substances that selectively inhibit those specific features of cell metabolism which are characteristic of the malignant growth.

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Arno B. Luckhardt, Physiologist

Arno Benedict Luckhardt was born in Chicago, Illinois, on 26 August 1885, the son of Gustav Adolph and Aurelia (Weber) Luckhardt. At the age of 12 he entered Conception College—then a Benedictine abbey—in Missouri, and in 1903 he entered the University of Chicago, from which he received the B.S. degree in 1906. This was followed by the Ph.D. degree in 1911 and the M.D. degree from Rush Medical College in 1912. On 24 April of the same year he married Luella Catherine LaBolle, and she and their three children—Hilmar Francis, Paul Gregory and Mary Aurelia (Miesse)—survive him.

His entire professional life was spent at the University of Chicago. Beginning as an assistant in bacteriology in 1908, he joined Anton Julius Carlson in the department of physiology in 1909 and advanced through the department, attaining the rank of professor in 1923 and the designation of Dr. William Beaumont Distinguished Service Professor in 1947. After retiring to the status of distinguished service professor emeritus in 1950, he continued his professional interests and activities to the end of his life. He died in Miami Beach, Florida, on 6 November 1957, and is buried near the former home of his wife, at Somonauk, Illinois.

This simple chronological statement does not begin to do justice to the talented, versatile, and dedicated person that was Arno Luckhardt. He was, first and foremost, a teacher and investigator in physiology. His pupils were many, and he was especially beloved by his graduate students, to whom he gave himself unstintingly. He will be best remembered for his introduction of ethylene gas as an anesthetic, but his contributions relative to the physiology of gastric secretion, gastrointestinal motility, the visceral sensory nervous system, and the function of the parathyroid glands were equally outstanding. As a result of his work, for example, it became possible for the first time to keep experimental animals alive following complete removal of the parathyroid glands and to prevent and relieve parathyroid tetany, which customarily followed this operation; his methods were applied successfully in human surgery.

It was characteristic of Arno Luckhardt that when he became interested in the potential anesthetic properties of ethylene gas, which he was the first to recognize, and after having performed the appropriate experiments with animals, he and his associate, J. Bailey Carter, inhaled it and put themselves to sleep. A demonstration was given to physicians and surgeons on 14 March 1923, and within three days the gas was in use as an anesthetic at the Presbyterian Hospital of Chicago. Having become convinced that he had made a significant discovery, Luckhardt records the fact that he himself inhaled an ethylene-oxygen mixture to the point of anesthesia some 700 to 800 times, without any bad aftereffects. After 900 successful operations under ethylene-oxygen anesthesia had been recorded, it was given to the public and the profession free, and without patent rights to anyone; this is in striking contrast to the attempts at commercial exploitation that followed the introduction of ether anesthesia in 1846. Luckhardt's discovery not only resulted directly in the introduction of a new and improved anesthetic; it also gave added impetus to the search for other new agents and new methods of administering them, and to the steps leading to the creation of a new specialty of anesthesiology.

Arno Luckhardt was a man of many interests; he was attracted to the problems of dental care and cooperated actively with dentists and dental organizations in promoting higher professional standards in dental therapeutics and in dental journalism. He was also active in cultivating closer medical-dental relationships in the interest of obtaining a higher level of health care for the public. In 1930 he became a charter member of the Council on Dental Therapeutics of the American Dental Association and served on this council until 1948. In recognition of his services to dentistry he was made an honorary fellow of the American College of Dentists in 1933. On 4 November 1957, two days before his death, he was made an honorary member of the American Dental Association, at its meeting in Miami Beach, Florida, and addressed the association in response.

His wide interests included the history of the medical sciences, and he made significant contributions in many areas, notably to the record of William Beaumont's studies of the physiology of digestion. He collected Beaumontiana, and also a large and important library of books and pamphlets related to the history of medicine. But he was more than a collector; his early education in Medieval Latin gave him the ability and the urge to read and enjoy many classics of medicine in the original. He collaborated with James Henry Breasted in the interpretation of the Edwin Smith surgical papyrus, "the oldest scientific book in America and the oldest nucleus of really scientific medical knowledge in the world." He acquired a unique collection of medical manikins, which gave him much pleasure.

Luckhardt served on the Council of the American Physiological Society; he was secretary from 1930 to 1932 and president from 1932 to 1934. He was president of the Federation of American Societies for Experimental Biology in 1934. He was active in the Society for Experimental Biology and Medicine and served on its editorial board and as associate editor of the *Proceedings*. As a Rockefeller fellow he visited Germany in 1924–25 and during his visit was elected to membership in the Kaiserliche Akademie der Naturforscher. For many years he was a member of the Chicago Literary Club, and he served a term as president. He was one of the founders of the Gamma Alpha graduate scientific fraternity.

Scientist, scholar, and teacher, Arno B. Luckhardt made a great contribution to his university, his profession, his fellow scientists, and his pupils. Physiology, medicine, surgery, and dentistry have been enriched by his contributions to human welfare. But the man was greater than the sum of his parts; his memory will live long with the many who admired, respected, and loved him and his works.

FRANKLIN C. MCLEAN
University of Chicago

News of Science

National Science Foundation Budget

The National Science Foundation budget for fiscal year 1959 will be $140 million if the President's recommendations are followed by Congress. This amount is exactly $100 million greater that the 1958 appropriation; how the actual appropriation for 1959 will compare with the current $40 million will depend upon Congressional action. The proposed increases are spread over practically every item in the foundation's budget, but the largest increases are in the field of science education, for which approximately a fivefold increase has been recommended.

Estimated expenditures for 1958 and budget proposals for 1959, expressed in thousands of dollars, for some of the major items are given in Table 1. The proposed research facilities and the amounts for each are: biological research facilities, $2 million; southern hemisphere astrograph, $1.2 million; solar research telescope, $5 million; radio and optical astronomy facilities, $700,000; and university nuclear reactor facilities, $1.5 million.

The foundation plans to increase all of its fellowship programs and to start some new ones. The smallest increase is in the regular predoctoral fellowships, which will increase from 776 to 970 if appropriations are granted. The increase in regular postdoctoral fellowships is from 100 to 200; in senior postdoctoral fellowships from 42 to 100; and in science faculty fellowships from 90 to 300. The following new fellowship programs are planned: 2500 summer fellowships for high school science and mathematics teachers (these are in addition to the institutes that have been conducted for several years and that are mentioned below); 2000 summer fellowships for college and university teaching assistants to enable them to study or engage in research during the summer months; 800 pre-service fellowships for persons who would like to become high school teachers of science or mathematics but who have not received the necessary education; and 1250 training grants for fellows who would be chosen jointly by the foundation and the university at which the recipient planned to take his graduate work.

The summer institute program is in for a big increase if plans go through. Institutes for high school teachers would be increased in number from 103 to 320, and institutes for college teachers from 5 to 36. In addition, support would be available for 20 short-term (about 2 weeks) summer conferences on special topics for college teachers, for 10 summer institutes for members of the faculties of technical training institutes, and for 20 summer institutes for elementary school supervisors who want additional training in science or mathematics.

Institutes lasting through the academic year are also scheduled to increase in number. The increase for regular, full-time institutes for high school teachers is from 17 to 30, and for institutes (usually on Saturdays) for teachers who are in service from 30 to 200. Comparable in-service institutes for elementary school teachers have not been offered by the foundation in the past, but 125 are scheduled in the new budget.

Two entirely new programs are planned to give special opportunities for science instruction or research experience to students. One of these programs would provide science instruction for from 4 to 8 weeks, on 80 campuses, for 4000 able high school students. The other would provide research experience for 1500 selected college undergraduates in special institutes offered on 60 campuses.

Table 1. National Science Foundation budget in thousands of dollars.

Item	Estimated expenditure for 1958	Proposed budget for 1959
Support of basic research (approximately evenly divided between physical and biological sciences)	$16,000	$40,000
Research facilities (about 5/6 in physical sciences)	6,000	12,000
Survey and reports on scientific resources	174	290
Dissemination of scientific information	855	1,879
Attendance at international meetings	125	500
Research on scientific information problems	266	414
Pre- and postdoctoral fellowships	3,265	21,000
Institutes for teachers	9,790	35,500
Special projects in science education	655	15,400
Improvement of course content	611	6,000
International science education program	0	1,000
Clearinghouse for scientific manpower information	248	830

Parliament of Science

The planning committee for the AAAS Parliament of Science that is to take place in Washington, 15, 16, and 17 March (see editorial, 9 Feb.) has released a statement which includes the background philosophy that led to the meeting and that guides the committee in its planning:

"The power of man through science is currently assuming a new order of magnitude. Power has always been sought avidly. Sometimes it has been used disastrously; often it has been used wisely. How America shall keep abreast of the developments in science and scientific technology; how it shall help avoid disaster; how it shall ensure that new knowledge (the age-old synonym for power) will be used for the benefit of mankind in general and its citizens in particular are among the most important questions before the public today.

"But the American public is disturbed, worried, and confused. We were supposed to be well in the lead, scientifically and technologically. Now, all of a sudden, this comfortable assumption is challenged. We are 'behind.' It isn't clear just what this statement means, or whether the serious versions of its possible meanings are in fact true. But there is no denying the general concern, and the almost frantic determination to 'do something about it.'

"The concern and the determination are, we believe, justified. But it is imperative that we sort out our ideas, brush off as superficial certain spectacular but minor items, and try to see our problem in its true dimensions.

"Not long after the discovery of fission, we began to sense the fact that man's impending control of atomic and nuclear power made possible, and indeed made inevitable, the beginning of a new age. As the still more vast potentialities of fusion were made available for destructive purposes, and as it became clear

that these incredible forces would presently be tamed for nonmilitary use, the magnitude of our break with the past became visibly greater and greater.

"We are just beginning to see that even these advances, tremendous as they are, constitute the signal, rather than the substance, of what is to come. Our successful probing into the nucleus of the atom is but an example of the clear fact that science is entering a new and accelerated stage of advancement, which will give to man the possibility of control over his environment, over himself, and over his destiny, which we have as yet only vaguely sensed. By probing the atom, man is exploding into the universe. With prospects that are—just as they were in the case of nuclear energy—both marvelous and frightening, we are on the threshold of an equally revolutionary probing of the cell and of the mind.

"Man is breaking with the past, its limitations and its safeguards. The prize is greater than ever before—so are the risks. The question is not, 'Do we like this?' The question is, 'What role do the people of the United States wish to play in the drama of the future?' We cannot hide. We must not relax. How can we play a noble part?

"What concerns us here is far and away larger than any question about a satellite, or even about a battery of long-range guided missiles, although these dramatic devices have precipitated discussion, and have produced a readiness to consider drastic action.

"We are in fact saying that man is on the very edge of a new relation to the atom, to the cell, to himself, and to the universe in which he is set. Many forces have been active, but clearly it is science which has been chiefly instrumental in bringing about this new relation. The new relation will place new demands on all man's resources—especially on his capacity to handle this new power with restraint and decency.

"This scientific revolution will totally dwarf the industrial revolution and the other historical instances of great social change. It will be more compelling, and will pose more urgent problems, due both to the pace and the magnitude of the changes which now impend.

"What faces man is not, in any restricted sense, a scientific problem. Scientific issues are vitally and almost universally involved. The special knowledge of the scientist is necessary, to be sure; but that knowledge would be powerless or dangerous if it were not effectively pooled with the contributions of social scientists, humanists, statesmen, and philosophers and brought to the service of all segments of our society.

"What on earth—excuse us, it is difficult to adjust—what in the universe ought we to do? The scientists certainly have no arrogant illusion that they have the answers. But they do want to help. At the very least, they have the duty of briefing their colleagues in other fields. They are, moreover, convinced that the time is overripe for a more understanding collaboration between their special profession and the rest of society.

"Because it is urgent for scientists to organize their own thinking about the problems raised in the preceding paragraphs, and urgent for society to understand those problems and their implications, the Council (the legislative body) of the American Association for the Advancement of Science decided that the Association should convene a special meeting, widely representative of all fields of science, to consider certain definite and pressing aspects of the current problems. For obvious practical reasons, the discussion will be largely restricted to actual proposals for increasing support for science and improving education."

Exchange of Scientists

During the 5-year period 1952–56, 6108 scientists participated in the State Department's international educational exchange program. Of the total number of persons exchanged during that period, one out of every five was a scientist.

Of the nearly 5000 scientists who came to the U.S., the largest number were in the field of medicine; others were in engineering, chemistry, physics, mathematics, and biochemistry.

More than 1200 American scientists went abroad to lecture, study, or conduct advanced research. The largest groups were in physics, chemistry, engineering, and mathematics.

The range of scientific pursuits which relate to peaceful uses of atomic energy has grown tremendously in the last few years. During 1956, 183 exchanges under the State Department's program were related to such endeavors.

Research in Human Behavior

A citizens' group of 15 people closely associated with behavioral science urges a national effort to expand research in human behavior as a means of fostering improved international relations and strengthening national defense. In a 7000-word statement the group describes the perils of inaction in the "sciences of man" and outlines a series of recommendations for action by both governmental and private agencies.

The group, which is a temporary body, was organized some 3 months ago by James G. Miller, director of the Mental Health Research Institute at the University of Michigan. It came into being following a discussion with Vice President Richard Nixon. The proposed program was also discussed with James R. Killian, Jr., special assistant to the President for science and technology, and with members of his committee. The Ford Foundation awarded a grant to the AAAS to support the group's work.

The statement, which may be obtained from Dr. Miller, says, in part:

"The present situation facing our country calls for an evaluation of the role and potential contribution of behavioral science. This is the combined endeavor of many fields, investigating all aspects of behavior leading to understanding of human beings as individuals and in social relations.

"Behavioral science therefore includes many studies in the fields of anthropology, biochemistry, ecology, economics, genetics, geography, history, linguistics, mathematical statistics, neurology, pharmacology, physiology, political science, psychiatry, psychology, sociology, and zoology.

"Applications ramify into advertising, business administration, education, government, human engineering, labor relations, law, medicine, military science, operations research, personnel selection, public relations, and many other aspects of human endeavor. Some of these sciences are still in early stages of development, but American research in them at the moment has a clear lead over Russian, which is constricted by Communist dogma.

"Behavioral science has demonstrated its usefulness to human welfare and national security. Its further development could increase its contribution in areas of international relations, military defense, and national vigor.

"To accomplish these goals, the following recommendations are offered:

"I. Formation of an advisory panel of behavioral scientists to work closely with the special assistant to the President for science and technology. There is need for more understanding, backing, and use of behavioral science throughout the government and by the people of the United States, and for encouraging the scientists themselves in their research tasks.

"II. Provision of increased funds for behavioral science research, training, and facilities in the National Science Foundation, the Department of Defense, the National Institutes of Health, the Atomic Energy Commission, and other appropriate governmental and private agencies, in order to: (i) establish additional university programs or institutes to conduct research in designated crucial areas; (ii) finance more fellowships, both predoctoral and postdoctoral, especially in all the social sciences; (iii)

increase financial support for basic research in behavioral science; (iv) make available special facilities for behavioral science, including buildings and equipment; and (v) support centers devoted to foreign area studies."

Revised Apportionments on Fish and Game Restoration

Revised apportionments of federal aid funds to the states for restoration of fish and game have been announced by the Department of the Interior. The new apportionment is based on Treasury certifications of money available from excise taxes on certain sporting goods. Under the revisions the 48 States and Hawaii will receive $21,306,000 for fish and game restoration instead of the $25,130,000 previously announced. The revised figure for game restoration is $16,974,000 compared with the $19,130,000 allotted previously; the amount available for the restoration of fish is $4,332,000 instead of $6,000,000.

This money is distributed to the individual states and to Hawaii in accordance with formulas established by law and based upon license sales and land and water areas. Distribution is made on a reimbursable basis, with the states financing projects initially and being repaid $3 in federal aid money for each $4 expended, or a net expenditure of $1 state money and $3 from federal funds.

In addition to the afore-mentioned apportionments, Alaska is to receive $90,000 for game restoration and $75,000 for its sport fishery. Guam, Puerto Rico, and the Virgin Islands will each receive $12,000 for game restoration, and each will get $10,000 for fish restoration. These amounts are fixed by law rather than by formula.

Legislation also provides that no state can receive more than 5 percent of the total apportioned for game restoration, nor can it receive less than 0.5 percent of that amount. Limits for fish restoration apportionment are 5 percent maximum and 1 percent minimum.

Kolthoff Comments on Soviet Trip

I. M. Kolthoff, head of the analytical chemistry department of the University of Minnesota, has recently returned from the U.S.S.R., where he attended a symposium for scientists in his field and lectured at Moscow University. Some of his comments about the trip follow.

"When I arrived in Moscow December 1 it had been 12 years since my last visit to the Russian capital. The great official respect for scientists and the prestige of the Russian Academy of Sciences which were already quite evident in 1945 were made plain to me immediately again. At the airport, the reception committee expedited my passage through customs and immigration procedures with no fuss or red tape and no bother to me.

"I had been invited to Moscow to take part in a three-day symposium. . . . Other participants . . . included 18 scientists from the 'satellite' countries. . . . Harry Irving of Oxford University was the only other guest from a capitalist country.

"There were, in addition, three Chinese chemists present—two men and a woman. One of the men and the young lady had taken their Ph.D. degrees in the United States (University of Wisconsin, 1937, and University of Illinois, 1951). . . . The third Chinese chemist had won his Ph.D. at the University of Munich under the late Professor Hoenigschmidt, one of the world's experts on the determination of atomic weights.

"Although all three Chinese were avowed Communists and supporters of the Red Government in Peiping, the two American-educated chemists referred with affection to their stay in the United States. Indeed, throughout all the many talks and discussions which we had in Moscow, Irving and I never heard a disagreeable word about the United States and Britain.

"The Chinese trio spoke flawless English, and we conversed without inhibition. They admitted that their education system is not yet as advanced as Russia's; it is possible to get only a bachelor's degree in China. But they hope study for advanced degrees will become possible reasonably soon.

"I was impressed by the large number of Chinese studying for advanced degrees at Moscow University. This educational link between Russia and China is not without significance in world affairs, and I could not help regretting once again our government's policy which makes it impossible for us to play a part in training China's future scientific and educational leaders.

"The Chinese chemists invited me to visit them at home and proposed to have an official invitation extended to me on their return. I would have been happy to accept, but sadly had to admit that again in this respect State Department policy might stand in the way.

"This is too bad, for scientific visitors like myself are in a unique position to establish much-needed relations with countries like China. From scientific contacts frequently come exchanges of opinion on other matters.

"As to scientific research in the Soviet Union, we found that—as was true in 1945—most work is carried out in special institutes, which are under the auspices of the U.S.S.R. Academy of Sciences and entirely separate from a university. Except for the fact that most of the advanced research workers also teach at a university (with extra pay), there is no direct relationship between a university and the institutes. . . . Emphasis is entirely on fundamental research, for which apparently unlimited funds are being made available.

"In 1945, I had noticed that practically none of the instruments and equipment was of Russian make. This time I was impressed, if not awed, by the fact that almost all the instruments for refined measurement are made in Russia. . . . .

"The number of research workers in chemistry is greater in Russia than in this country. The quality of their work varies from excellent and good to acceptable. Their papers and journals, in general, compare favorably with those in the Western World. . . . [But] the great advancements in pure and applied science are brought about by contributions of an original and fundamental nature. In this respect the Russians have not got the lead over the West as far as chemistry is concerned. But they definitely hold their own. . . .

"There is no reason for hysteria now. But we do need fully to recognize the fact that fundamental research is the source of applied research and that no nation can remain strong without leadership in basic research."

Grants, Fellowships, and Awards

Behavioral sciences. The most serious difficulty encountered by the Russell Sage Foundation in its work for more effective collaboration between the social sciences and the professional services is the scarcity of trained personnel. In order to help meet this shortage, the foundation offers postdoctoral residencies in operating agencies or professional schools for the purpose of providing qualified sociologists, social psychologists, and anthropologists with specialized training and experience relevant to professional practice. Award recipients must not be over 35 years of age and must definitely be interested in careers involving applications of behavioral science in a field of professional practice. For information, write to the Russell Sage Foundation, 505 Park Ave., New York 22, N.Y.

Biophysics. The Massachusetts General Hospital has established a biophysics training program designed to assist candidates holding doctorate degrees in mathematics, physics, or engineering to apply their knowledge to biological and medical problems. This program is supported by the National Institutes of Health and is presented with the co-

operation of Massachusetts Institute of Technology. Appointments will be for a minimum period of two or three years. The salary range will depend on previous research experience and other qualifications. For information, communicate with the Physics Research Laboratory, Massachusetts General Hospital, Fruit St., Boston, Mass.

Gravity. The Gravity Research Foundation has announced that for the ninth year it is offering five awards for short essays on gravity. The awards will be made on 2 June for the best 1500-word paper on the possibilities of discovering: (i) some partial insulator, reflector or absorber of gravity, or (ii) some alloy, or other substance, the atoms of which can be agitated or rearranged by gravity to throw off heat, or (iii) some other reasonable method of harnessing, controlling, or neutralizing gravity. Essays must be received *before 15 April* by the Gravity Research Foundation, New Boston, N.H. The foundation will send detailed instructions on request.

Medical student research. The Lederle Laboratories Division of the American Cyanamid Company has announced that it is making available to medical schools throughout the United States and Canada its publication, *Lederle Medical Student Research Fellowships.* These fellowships, in amounts not exceeding $600 per year for any one individual, are intended to relieve in part the financial burden of students who desire to devote their summer vacations to research in the preclinical departments. The selection of students to receive such awards will be made by the dean of the medical school, or by the regularly constituted committee of the faculty charged with such selections.

News Briefs

Beginning 31 March, the Atomic Energy Commission will no longer accept new requests for gamma irradiation service from the public when the requested service is readily available commercially. A recent commission survey indicates that at least 16 academic and industrial organizations are prepared to provide gamma irradiation service on a commercial basis. A list of these organizations, showing the gamma flux available, the number and size of samples that can be accommodated, and the approximate amount of space available, may be obtained from the Office of Industrial Development, Atomic Energy Commission, Washington 25, D.C.

* * *

The Crop Protection and Pest Control Exhibition that is being organized by *World Crops,* international journal of agriculture, will be held 12–15 May at the Royal Horticultural Society's new hall in London. The organizers hope for a minimum attendance of 25,000, drawn from all over Europe.

* * *

Russell Cave, near Bridgeport, Ala., the oldest known site of human habitation in the southeastern United States, has been given to the Federal Government by the National Geographic Society as a national archeological monument.

* * *

As part of the safety precautions for the forthcoming nuclear tests at the Eniwetok Proving Ground, the U.S. Atomic Energy Commission has announced the danger area that will be established in the Pacific Ocean effective 5 April. The area is generally rectangular in shape and comprises roughly 390,000 square nautical miles. It is approximately the same size as the danger area used in the 1956 test series, but its east and west boundaries have been shifted approximately 120 nautical miles to the west. It is estimated that most, if not all, of the danger area will be disestablished during August 1958.

* * *

Plans for the new museum building of history and technology for the Smithsonian Institution have been approved by a Special Joint Committee of the Senate and House of Representatives, the Regents of the Smithsonian Institution, the Commission of Fine Arts, the National Capital Planning Commission, and the General Services Administration. Construction will start early next summer.

* * *

The following chemicals are wanted by the National Registry of Rare Chemicals, Armour Research Foundation of Illinois Institute of Technology, 13 W. 33rd St., Chicago 16, Ill.: 2-hydroxy-*n*-caprylic acid; α-methyl styrene oxide; *p*-dinitrosobenzene; *l*-ethylcyclohexanol; *m*-hydroxyphenylpropionic acid; monofluoroacetic anhydride; *n*-pentacosane; *l*-phenylcyclohexene; *n*-dotriacontane; 4-chloro-2-hydroxy-3,3-dimethylbutyric acid; pentaphenylethane; *n*-tetracosane; 2,4-dichloro-3,3-dimethylbutyric acid; mellon; cinchomeronic acid (pyridine-3:4-dicarboxylic acid); α,α-dimethylsuccinic acid; 1,2-anthraquinone; diethyl disulfide; humulene; and 2-methylacrylic acid (isocrotonic acid).

* * *

A millenary celebration for Al–Mas'udi, 10th-Century Arab geographer, traveler, and encyclopedist, was held recently in India at Muslim University, Aligarh, under the joint auspices of the Institute of Islamic Studies, Aligarh, and the Indian Society for the History of Science. In addition to the many Indian papers presented, there were some 30 papers from different parts of the world, including the United Kingdom, the United States, the Soviet Union, France, the Netherlands, Egypt, Lebanon, and Iran. Among those present from abroad were Bernard Lewis, Von Grunebaum, Myron Smith, Academician Tolstov, Nicola Ziadeh, and Said Naficy.

* * *

The Columbia Broadcasting System has announced that a televised symposium on science, "The Role of the Scientist in America's Future" will take place on 16 March from 5 to 6 P.M. Participants will include Joseph Kaplan, Howard L. Bevis, Clifford C. Furnas, and William L. Laurence of the *New York Times.*

* * *

The National Science Foundation has announced plans for a conference on "Research and Development and Its Impact on the Economy," to be held in Washington in the spring. The conference will focus attention on the economic importance of the nation's research and development activities, now estimated to account for annual expenditures of about $10 billion, more than 2 percent of the gross national product. The effect of such expenditures in stabilizing and promoting the growth of the economy, especially in periods of recession, will be one of the principal topics of discussion.

Scientists in the News

LAURENCE H. SNYDER, retiring president of the AAAS and chairman of its board of directors, will become president of the University of Hawaii on 1 July. He is at present dean of the Graduate College at the University of Oklahoma.

MANSON BENEDICT, professor of nuclear engineering, has been appointed head of the department of nuclear engineering that is to be established at Massachusetts Institute of Technology.

Under the new cultural and technical exchange agreement between the United States and the U.S.S.R., HUBERT A. LECHEVALIER, an associate professor of microbiology at the Rutgers Institute of Microbiology and codiscoverer of neomycin, plans to leave for Moscow in about 6 months. Lechevalier is an assistant to Selman A. Waksman, winner of the 1952 Nobel Prize in physiology and medicine as codiscoverer of streptomycin.

In exchange, the Soviet Union has agreed to send the Rutgers Institute G. K. SKRIABIN, a ranking member of the microbiological research team directed by N. A. Krassilnokov of the Soviet Academy of Sciences. Skriabin is expected to arrive here early in March.

BALTHASAR VAN DER POL, director of the International Radio Advisory Committee in Geneva, Switzerland, will hold the Victor Emanuel professorship at Cornell University for the spring term. Van der Pol gained international prominence for his discovery of relaxation oscillations, and he has made significant contributions to pure mathematics, particularly in number theory.

HARRY WEXLER, director of the Weather Bureau's Office of Meteorological Research, has been awarded the Department of Commerce gold medal "for significant contributions to the science of meteorology in extending the knowledge of the upper atmosphere, for the direction and encouragement of a broad program of meteorological research, and for outstanding leadership in the 1957–58 International Geophysical Year program." Wexler is chief scientist of the U.S.–IGY Antarctic Program.

HENRY G. HOUGHTON of Massachusetts Institute of Technology has received the American Meteorological Society's Award for outstanding services to the society. He was honored "for his important contributions to the growth of the American Meteorological Society through his guidance as president, as secretary, and his unfailing service in Council and Committee work."

Navy Distinguished Public Service Awards, the highest honor the Secretary of the Navy can bestow upon civilians, were presented recently to the director and four members of the staff of the Johns Hopkins University Applied Physics Laboratory, Silver Spring, Md. At the same time Navy Meritorious Public Service Citations, the second highest honor, were presented to four other members of the laboratory staff. All the awards were made for work on the Terrier guided missile.

Those who received the Distinguished Public Service Awards were RALPH E. GIBSON, director of the laboratory since 1947; ALEXANDER KOSSIAKOFF, assistant director for technical operations; HENRY H. PORTER, assistant director of planning; RICHARD B. KERSHNER, supervisor of the Terrier division; and ROBERT C. MORTON, supervisor of the Terrier weapons system group.

Those who received the Meritorious Public Service Citations were ALVIN R. EATON, JR., supervisor of the aerodynamics group; RICHARD T. ELLIS, supervisor of the Terrier development and test group; ROLAND W. LARSON, the supervisor of the Terrier electronics group; and THOMAS W. SHEPPARD, assistant supervisor of the Terrier division.

JOSEPH S. MITCHELL, Regius professor of physics at the University of Cambridge (England), will deliver Harvard University's annual Dunham lectures on 10, 12, and 13 March on "Studies in Radiotherapeutics."

SAVERY F. CONEYBEAR has been named to the newly created position of director of new products development at the Colgate–Palmolive Company, New York, N.Y. He was formerly a director of research in the company's research and development department.

FINN BRUDEVOLD, director of dental research at the Eastman Dental Dispensary and assistant professor of dental research at the University of Rochester, has been appointed professor of dentistry at Harvard University and chief of dental medicine at the Forsyth Dental Infirmary. His appointment will be effective on 1 August. Brudevold will participate in the new postdoctoral program in dental education being undertaken jointly by Harvard and Forsyth that makes available to outstanding students the opportunity of training for a career in academic dentistry.

VINCENT G. FITZSIMMONS, consultant of the Naval Research Laboratory, has been awarded the Meritorious Civilian Service Award, the Navy's second highest award, in recognition of his "role in the development of new lubricant systems for both military and industrial uses."

HENRY K. BEECHER, Dorr professor of research in anesthesia at Harvard Medical School, lectured recently before the Royal Society of Medicine in London. Also, he has been invited to be one of the chairmen at a symposium, to be held 24 and 25 March in London under the sponsorship of the Wellcome Trust, on quantitative methods in human pharmacology and therapeutics.

EDMUND A. PRENTIS, who took his degree in mining engineering at Columbia University in 1906, has been selected as the recipient of the 1958 Alexander Hamilton Medal of the Association of the Alumni of Columbia College. The Medal, which will be presented at a dinner at the university on 30 April, is given annually to a former student or a member of the college faculty "for distinguished service in any field of human endeavor." Prentis, for many years a member of the New York engineering firm of Spencer, White and Prentis, has been a director of many important engineering projects, including the 1950 reconstruction of the White House and construction of tunnels for New York subways.

MANUEL F. MORALES, former head of the physical biochemistry division of the Naval Medical Research Unit at Dartmouth College, has assumed his new position as professor of biochemistry at Dartmouth Medical School. LAFAYETTE H. NODA, DOROTHY JEAN BOTTS, and SIDNEY A. BERNHARD, have been appointed associate professors of biochemistry to collaborate with Morales.

ALLAN R. A. BEEBER has been appointed vice president for research and development for the Arkwright Finishing Company, Fiskeville, R.I. He was formerly director of research for the Keuffel & Esser Company in Hoboken, N.J.

Recent Deaths

JOSEPH E. AVENT, Knoxville, Tenn.; 79; retired professor of educational psychology at the University of Tennessee; former president of Martha Washington College at Abingdon, Va.; 12 Feb.

BELA C. BALAS, Newton, N.J.; formerly a physician in New York; had been an associate professor at Loyola University in Chicago for 16 years; 16 Feb.

AARON BESNER, Bronx, N.Y.; 36; nuclear physicist; had been working on the development of a nuclear-powered locomotive for the Walter Kidde Nuclear Laboratories, Garden City, N.Y.; 14 Feb.

JOHN H. CLEWELL, Montclair, N.J.; 71; retired associate director of E. I. du Pont de Nemours & Co. research laboratory in Arlington; 11 Feb.

ARCHIBALD EDGAR, Yonkers, N.Y.; 64; mechanical technician with Columbia University's cyclotron laboratories in Irvington, N.Y.; 12 Feb.

A. S. GIORDANO, Sarasota, Fla.; 65; pathologist and serologist of South Bend, Ind.; for 30 years director of the South Bend Medical Foundation; performed research on diagnoses of brucellosis and serology of syphilis; 15 Feb.

WALTER S. HUXFORD, Chicago, Ill.; 65; professor of physics at Northwestern University and former director of research for the National Defense Research Council; 13 Feb.

HAROLD R. MIXSELL, Locust Valley, N.Y.; 72; pediatrician; former editor of *Archives of Pediatrics*; 14 Feb.

CONSTANTINE RICCIUTI, Philadelphia, Pa.; 38; research chemist at the laboratory of the U.S. Department of Agriculture, Wyndmoor, Pa.; 10 Feb.

FRANCIS E. SENEAR, Winnetka, Ill.; 68; retired professor and head of the department of dermatology of the University of Illinois Medical School; 12 Feb.

Reports

Growth of Children of the Same Race under Different Environmental Conditions

Numerous observations on the rate of physical growth and development of children of different racial groups have been made in recent years, especially in connection with nutritional surveys conducted under the auspices of the World Health Organization and other international agencies in various parts of the world. In general, the children studied have been reported to be somewhat retarded or, in other cases, much retarded in their growth and development as compared with Caucasian children of the same sex and age in the United States. There has been a tendency to attribute the observed retardation, at least in part, to racial differences in the rate at which growth and development proceed. It is believed that the findings here reported briefly indicate the desirability of reexamining the assumption that such racial differences do in fact exist.

We recently compared the stature, weight, sitting height, and skeletal age of 898 American-born Japanese children in California with the corresponding characters of children of the same sex and age in Japan (*1*). As had been anticipated, the California children were found to be significantly taller, heavier, and more advanced in their skeletal development than comparable children in Japan, but the magnitude of the observed differences had not been anticipated.

At every age included in our study (6 to 19 years), the American-born Japanese boys exceeded in average stature the boys of Japan by an amount greater than the increase which has taken place in the average stature of the boys of Japan since the beginning of the present century (Fig. 1). The American-born Japanese girls exceeded the girls of Japan in average stature to a like degree, but only up to the age of 14 years. Thereafter, their superiority in average stature, though considerable, was somewhat less than the average gain in stature for the girls of Japan since 1900 (Fig. 2). This sexual difference is believed to have its basis in the relatively greater increase which has occurred in the average stature of the women as compared with the men of Japan during the last half-century.

Since the ratio of sitting height to stature is usually considered to be a racial character, it was rather surprising to find that, up to about the time of puberty, the American-born Japanese boys and girls were distinctly longer-legged than the children of Japan. Early in adolescence, however, the two groups became almost indistinguishable in ratio of leg length to total height.

It is evident, therefore, that during the prepuberal years the growth of the lower limbs of the Japanese children living in California was greater in proportion to the growth of the rest of their bodies than that of the children of Japan during the same period. This is probably a result of the more rapid growth rate of the California children, which, in turn, seems to be attributable to their more adequate diet and to the other more favorable environmental conditions in which they were reared.

It should be noted that the more rapid growth rate of the American-born Japanese children did not modify significantly the ratio of sitting height to stature of the older children. Our findings, therefore, are consistent with the view that this ratio is a valid racial character of adult Japanese.

A finding of especial relevance to the question of the existence of racial differences in the rate of physical growth and development of children was provided by a comparison of the skeletal age of the American-born Japanese children with that of the Caucasian children of the Brush Foundation study on which the Greulich-Pyle radiographic standards of skeletal development are based (*2*). The latter groups consisted of a large number of healthy children from Cleveland (Ohio) families who were well above average in economic level. In general, these children were taller, heavier, and more advanced in their skeletal development than other groups of children in the United States for whom comparable data were available.

Of the American-born Japanese children, only the 5-, 6-, and 7-year-old boys were found to be significantly retarded in their skeletal development as compared with the Cleveland children of the same sex and age. There was no significant difference in skeletal status between the two groups of boys from 8 to 12 years of age, but from 13 to 17 years the American-born Japanese boys were significantly more advanced skeletally than the Cleveland boys. The skeletal development of the American-born Japanese girls from 10 to 17 years of age was significantly more advanced than that of the Cleveland girls. The two groups of girls did not differ significantly from

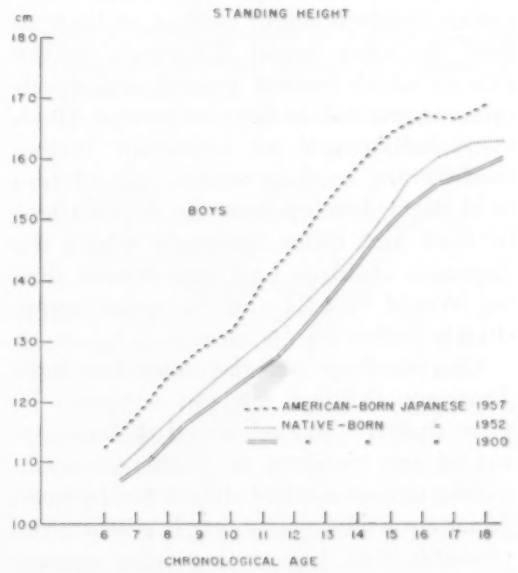

Fig. 1. Average standing height of American-born Japanese boys compared with that of boys in Japan, in 1900 and 1952.

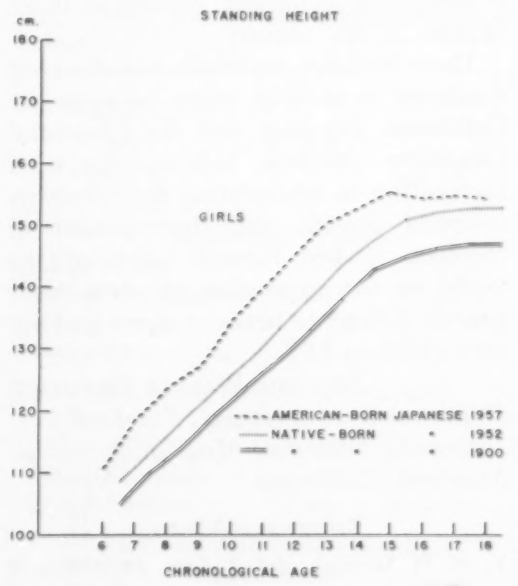

Fig. 2. Average standing height of American-born Japanese girls compared with that of girls in Japan, in 1900 and 1952.

All technical papers and comments on them are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table or one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* 125, 16 (4 Jan. 1957).

each other in skeletal status at any other ages included in our study.

The most extensive study of the skeletal development of children in Japan is that reported by Sutow (*3*) and by Sutow and Ohwada (*4*), who assessed hand radiographs made of 1220 boys and 1150 girls of Hiroshima during 1951–52. These were apparently healthy children who served as controls in the Atomic Bomb Casualty Commission's study of the children who survived the atomic bombing of that city. Sutow and Ohwada reported that, on the basis of the Greulich-Pyle radiographic standards, the Hiroshima children were less advanced skeletally than the Cleveland children at every age considered in their study—that is, from 6 to 19 years. Their relative retardation ranged from 6 to 24 months in boys and from 9 to 24 months in girls.

Sutow suggested that the observed retardation in the skeletal development of the Japanese as compared with the Caucasian children might be due, at least in part, to some racial difference in the rate at which normal growth and development proceed in the two groups. However, he stressed as important factors contributing to their relative retardation in skeletal development the deprivations in food and other essentials which the Japanese children had experienced during World War II and the years immediately following its close.

Our findings on the American-born Japanese children do not support the view that the less advanced skeletal status of the children in Japan is attributable to some racial difference between Japanese and Caucasians. It seems more probable that, like their smaller average stature and their relatively shorter legs during childhood, the skeletal retardation of the children in Japan results from a less adequate diet and from other environmental conditions which are not so conducive to optimal growth as those existing in this country.

These findings, especially the observed similarity in skeletal status between the California Japanese and the Cleveland Caucasian children, indicate the need for caution in interpreting the relatively retarded growth and development of children in less favored parts of the world as the expression of some basic genetic difference between them and our own children (*5*).

WILLIAM WALTER GREULICH
Department of Anatomy, Stanford University School of Medicine, Stanford, California

References and Notes

1. W. W. Greulich, *Am. J. Phys. Anthropol.*, in press.
2. W. W. Greulich and S. I. Pyle, *Radiographic Atlas of Skeletal Development of the Hand and Wrist* (Stanford Univ. Press, Stanford, Calif., 1950).
3. W. W. Sutow, *Hiroshima J. Med. Sci.* **2**, 181 (1953).
4. W. W. Sutow and K. Ohwada, *Clin. Pediat. (Japan)* **6**, No. 11 (1953).
5. The study on which this report is based was supported by grant A-624 from the National Institutes of Health and by a grant from the Wenner-Gren Foundation for Anthropological Research.

22 November 1957

Distribution of Incompatibility Alleles among the Complex-Heterozygotes of Oenothera

In earlier papers (*1*), evidence was presented indicating the presence of an incompatibility allele mechanism in oenotheras of the *biennis* group 1, a phylogenetic group of true-breeding translocation heterozygotes. This is a preliminary report (*2*) of the occurrence of incompatibility alleles in other phylogenetic groups of the genus *Oenothera*.

The oenotheras of *biennis* group 1 are composed of two genomes or "complexes" of seven chromosomes each. These are designated as the alpha and beta complexes and are characterized by completely different arrangements of their chromosome ends. As a result, at meiosis a circle of 14 chromosomes occurs, and only two kinds of spores are produced, one carrying the alpha, the other the beta, complex. Such plants, which are naturally self-pollinating, produce only alpha · beta combinations among the offspring. The absence of alpha · alpha or beta · beta combinations among the progeny is attributed to a balanced lethal system. In outcrossing these forms, it becomes apparent that one complex is transmitted to the offspring predominantly through the egg and the other largely through the pollen. This serves as a basis of distinguishing the alpha and the beta complexes, the latter coming through the pollen, the former through the egg.

In the *biennis* group 1 races, the alpha complex carries an incompatibility allele (S_1), while the beta complex carries an allele which has no incompatibility effect (S_f). The S_1 allele of the alpha complex serves as a pollen lethal, because in self-pollinations development of pollen carrying the alpha complex will be inhibited by the presence of the same S_1 allele in the style. The incompatibility allele mechanism thus acounts for one-half of the balanced lethal system so well known to *Oenothera*.

The incompatibility allele mechanism suggests an attractive hypothesis explaining the origin of the complex-heterozygotes. In two isolated populations showing orthodox cytogenetic behavior, the occurrence of random segmental interchange can, over a period of time, result in the differentiation of the two populations with regard to the arrangement of their chromosome ends. If interchange is extensive enough, the two populations may come to be characterized by completely different segmental arrangements. Let us suppose that one of these populations possesses an incompatibility allele system, while the other does not. If the two populations now come into contact and hybridization occurs between them, the hybrids will be complete translocation heterozygotes, producing only two kinds of spores. One of these will carry an S_1 allele; thus, pollen of this type will not develop in a self-pollination, and one type of segregate (alpha · alpha) which is structurally homozygous cannot occur. If megaspore competition occurs, and the complex carrying the S_1 allele is the one which succeeds in producing the embryo sacs, the other segregate which is structurally homozygous (beta · beta) will also be eliminated. Thus, such a hybrid will be true-breeding from its inception. In this way, the highly specialized oenotheras could have arisen simply through a single hybridization. Once established, of course, the nature of the cytogenetic mechanism allows the accumulation of recessive detrimental and lethal genes which reinforce the original balanced lethal system of incompatibility alleles and megaspore competition.

The strength of this hypothesis depends to a large extent upon the demonstration of the existence of incompatibility alleles in the other phylogenetic groups of complex-heterozygotes in the subgenus. If incompatibility alleles are found in the alpha complexes of most complex-heterozygotes, the hypothesis would seem to have general significance in explaining the origin of the complex-heterozygote.

Largely through the work of Cleland and his associates, several hundred collections of *Oenothera* from North America have been cytogenetically analyzed and classified accordingly into eight different phylogenetic groups (*3*). A study has been undertaken to survey the complex-heterozygotes among these collections for the presence of incompatibility alleles in their alpha complexes. The particular phylogenetic groups with which work has begun are the *strigosa*, the *biennis* group 2, the *biennis* group 3, and the *parviflora*. Some unforeseen difficulties in obtaining the critical hybrid combinations in many of the crosses has so far limited the collection of data regarding the distribution of incompatibility alleles in these groups. However, certain races (listed in Table 1) have been shown to possess incompatibility alleles.

It is interesting to note that the races *grandiflora* de Vries and Beaufort both

Table 1. Races of *Oenothera* which have been shown to possess incompatibility alleles.

strigosa	*biennis* group 2	*biennis* group 3	*parviflora*
Brookston	Indiana	Coudersport	muricata
	River	III	
Fargo	Victorini	Linville	
Granger	Waterbury	Mountain	
		Lake	
Heber		Newfound	
		Gap	
Iowa 6		Smethport	
Iowa 12			
Palmer			
Lake			

lack S_1 alleles. These races were previously interpreted as hybrids between the structurally homozygous, self-fertile *grandiflora* group and the *biennis* group 1 (*4*). The absence of incompatibility alleles in the complexes *neoacuens* (*grandiflora* de Vries) and alpha *Beaufort* confirm the earlier interpretation.

The above data indicate that incompatibility alleles may well be characteristic of the alpha complexes of most complex-heterozygotes. With the exception of the *grandiflora* de Vries and the Beaufort collections, all races which are complex-heterozygotes and which have so far been tested possess incompatibility alleles.

ERICH STEINER
MARY S. SCHULTZ
Department of Botany,
University of Michigan, Ann Arbor

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18 November 1957

Fractionation of Stable Isotopes of Sulfur by Thiobacilli

Tudge and Thode (*1*) have calculated thermodynamically that H_2S in equilibrium with elementary sulfur in aqueous solution shows no fractionation of the stable sulfur isotopes S^{32} and S^{34}. This can be interpreted to mean that during the oxidation of H_2S to sulfur, both isotopes react with equal rapidity. It was also found by Jones and Starkey (*2*) that *Thiobacillus thioxidans,* when it was grown on sulfur (it oxidizes sulfur to sulfate), likewise produced no fractionation.

In experiments carried out by our group with *Thiobacillus concretivorus* obtained in pure culture by C. D. Parker of the Melbourne and Metropolitan Board of Works (Australia) and grown on elementary sulfur, results not unlike those of Jones and Starkey (*2*) were obtained. The sulfur used was commercial sulfur and sulfur (of volcanic origin) from White Island, New Zealand. Very little fractionation was obtained in these experiments, and there certainly appeared to be no definite enrichment of the light isotope. Enrichment of S^{32} varied from +0.05 to −0.16 percent. Thus, if the results are to be taken as significant, there is a small enrichment of S^{34} during the oxidation

$$S \rightarrow SO_4^{--}$$

In preliminary experiments with *T. concretivorus* grown on H_2S as the sulfur source, enrichment of the lighter isotope could be detected when the products of the oxidation, sulfur and sulfate, were analyzed. Cultures of *T. concretivorus* were grown by C. D. Parker in an atmosphere containing approximately 200 ppm of H_2S at room temperature (20° to 25°C). After 8 to 10 days the sulfur which had formed as a pellicle was filtered from the culture medium, and the sulfate formed in the culture was precipitated as barium sulfate.

The results represented in Table 1 demonstrate that there is a significant enrichment of S^{32} both in sulfur and sulfate. In experiment 3, the sulfate was not precipitated in the culture solution but was separated by washing the filter papers, on which the sulfur was filtered, with water and then precipitating this solution with barium chloride. This may be the reason for the reduced enrichment.

In order to test whether fractionation occurs during abiological oxidation of H_2S, a Kipps apparatus was left standing for some weeks at approximately 23°C, and the sulfur formed at the top of the apparatus due to oxidation of H_2S was separated out. The sulfur showed a depletion of 0.3 ± 0.1 percent of the S^{32}/S^{34} ratio with respect to that of the H_2S, a change in the opposite direction to that of biological oxidation. This indicates that the biological oxidation of H_2S by *Thiobacilli* leads to an enrichment of S^{32} in the final products.

In addition to the afore-mentioned laboratory experiments, measurements were carried out on samples collected in natural environments where a sulfur cycle was in progress. The results represented in Table 2 indicate a definite enrichment of S^{34} in gypsum and sulfates with respect to the associated sulfur.

Although the sulfate in the concrete of sewers may be formed as a result of the biological and abiological oxidation of H_2S as well as of the microbial oxidation of sulfur (Parker, *3*), the gypsum crystals surrounding the sulfur nodules at Lake Eyre (South Australia) appear to be formed by the microbial oxidation of sulfur only (Baas Becking and Kaplan, *4*). It is difficult at this stage to interpret the results in order to establish with certainty whether an enrichment of S^{34} does take place, since part of the sulfate may redissolve and a physical fractionation may occur. Further, it is conceivable that a proportion of the gypsum found under these natural conditions may be of secondary origin, having at some stage entered a cycle in which sulfate reduction was taking place and so being enrichced in S^{34}. We draw attention to these factors as complications which deter us from drawing a definite conclusion. From field observations and under the conditions in which the samples were collected and analyzed, we consider, however, that the enrichment

Table 1. Fractionation of sulfur isotopes during the oxidation of H_2S by *Thiobacillus concretivorus.*

Sample	S^{32}/S^{34}	Relative enrichment of S^{32} (%)
Experiment 1		
Sulfide used	22.12	0.0
Bacterial sulfur	22.18	0.3 ± 0.1
Bacterial sulfate	22.29	0.8 ± 0.1
Experiment 2		
Sulfide used	22.14	0.0
Bacterial sulfur	22.27	0.6 ± 0.1
Bacterial sulfate	22.33	0.9 ± 0.1
Experiment 3		
Sulfide used	22.14	0.0
Bacterial sulfur	22.26	0.5 ± 0.1
Bacterial sulfate	22.28	0.6 ± 0.1

Table 2. S^{32}/S^{34} isotope ratios of sulfur and sulfate formed by the oxidation of sulfur.

Sample and locality	S^{32}/S^{34}	Relative enrichment of S^{32} (%)
Melbourne sewer		
Sulfur from concrete surfaces	22.29	0.7 ± 0.1
Sulfate from concrete surfaces	22.14	0.0
West side, Sulphur Peninsula, Lake Eyre		
Sulfur nodule	22.49	0.6 ± 0.1
Gypsum crystals around sulfur	22.36	0.0
East side, Sulphur Peninsula, Lake Eyre		
Sulfur nodule	22.34	0.4 ± 0.1
Gypsum crystals around sulfur	22.25	0.0

of S^{34} illustrated in Table 2 as a result of the biological oxidation of sulfur to sulfate is significant. This may be considered as further evidence confirming results on laboratory experiments that S^{32} is not enriched, but rather, depleted, during the oxidation of sulfur to sulfate by *Thiobacilli* (*5*).

I. R. KAPLAN*
Division of Fisheries and Oceanography, Commonwealth Scientific and Industrial Research Organization, Cronulla, New South Wales, Australia
T. A. RAFTER
Division of Nuclear Sciences, Department of Scientific and Industrial Research, Lower Hutt, New Zealand

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* Present address: Bacteriology Department, University of Southern California, Los Angeles 7, Calif.

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A New Strain of the Mouse Mammary Tumor Virus

The mammary tumor virus, transmitted from generation to generation through the mother's milk, is an important factor in the development of mammary tumors in mice. Although it has been postulated that this virus should show genetic autonomy and variability (*1*), this has not been established. The possibility that the mammary tumor viruses possessed by different inbred strains of mice may not be identical has been indicated by reports of differences in characteristics of tumor development (such as tumor incidence or mean age of tumor development) which occur when two such strains are crossed reciprocally (*2*). However, evidence of stable alterations in the activity of the virus within an inbred strain, in which the virus is detectable both before and after the change, has not been reported. To verify the assumption that the appearance of a new characteristic within a strain is the result of a change in the mammary tumor virus, it is necessary to compare the new and the original stocks in situations wherein the virus is the only variable, both in the test mice and in the females supplying virus to the test mice. In addition, the altered activity of the virus must be observed through several generations of mice to insure the stability of the change.

In our laboratory a fortunate combination of circumstances has resulted in a situation in which a change in a characteristic of an inbred strain of mice can be traced to an alteration in the activity of the mammary tumor virus. A line of Heston A mice (A/HeCRGL), inbred for over 85 generations, has been maintained in this laboratory since 1950. The mean age of mammary tumor development in the breeding females has consistently been about 12 months. In 1953 it was discovered that females in one branch of the stock were developing mammary tumors at about 8 months of age. This latter group was separated out, and it has been maintained separately as the A/viCRGL subline. It is at the present time in its 13th generation.

The experiments described below, in which all mice have been maintained as breeding females, were set up to determine whether this change in mean age of tumor development was the result of a change in the mouse or in the virus (*3*). In all experimental groups, some mice are still alive. Therefore, the final mean ages of tumor development may be slightly different from those reported here. However, the remaining mice are either so old or so few in number that their deaths (due to mammary tumors) will not affect the significance of the tumor age differences.

In the generations of stock mice concurrent with the experimental groups discussed below, 90 females of the A/He strain had a mean age of tumor development of 12.7 months; 111 females of the A/vi subline had a mean age of tumor development of 8.6 months (Table 1, experiment 1).

Reciprocal hybrids (34 A/He × A/vi hybrids, 51 A/vi × A/He hybrids) of the two stocks were collected, and their mean ages of tumor development were determined (Table 1, experiment 3). Each group of hybrid mice developed mammary tumors at a mean age similar to that of the strain to which their maternal parents belonged. These two groups of mice were identical genetically but differed in maternal influences.

Newborn mice of the A/vi subline were transferred to and nursed by females of the A/He strain and vice versa. Fourteen animals that received A/He milk either had a late age of tumor development or are alive and more than 13 months old, despite the fact that they are otherwise A/vi females; 25 females that received A/vi milk had an early mean age of tumor development despite the fact that they were otherwise A/He females (Table 1, experiment 2). Thus, the difference in mean age of tumor development is evidently mediated by factors carried in the milk.

The activity of the mammary tumor virus has been followed for two generations beyond the reciprocal hybrids by fostering females of the A/vi stock upon both groups of hybrids (Table 1, experiment 4) and by collecting the offspring of these fostered females (Table 1, experiment 5). In both of these generations, groups of 22 and 25 mice whose mammary tumor virus was originally from A/He mice are developing mammary tumors at a later age than did groups of 21 and 34 mice whose mammary tumor virus was originally from the A/vi stock. Thus, the two viruses have retained their difference in activity through these generations, despite the fact that the mice carrying each of them were similar in genotype in each generation. This eliminates the possibility that the difference in mean age of tumor development reported here is the result of a change in the genotype of the host which is expressed in the activity of the mammary tumor virus passed to the offspring.

Table 1. Summary of experiments involving the mammary tumor viruses of the A/He strain and the A/vi subline and their influence on the mean age of mammary tumor development in breeding female mice. Symbols designate genotype (in hybrids the female parent is mentioned first); numbers in parentheses indicate mean age, in months, of tumor development; arrows indicate transfer of the virus.

Expt.	Transfer of virus from A/He strain	Transfer of virus from A/vi subline
1	A/He (12.7)	A/vi (8.6)
2	↓ ↘ A/vi (> 12.8)	↓ ↘ A/He (9.6)
3	F_1* (13.1)	F_1† (9.4)
4	↓ A/vi (11.9)	↓ A/vi (9.6)
5	↓ A/vi (> 11.4)	↓ A/vi (9.4)

* A/He × A/vi. † A/vi × A/He.

The various experimental situations have shown the stability of the difference between the two viruses. Possible differences in the response of other strains of mice to these two strains of virus are being tested in a series of current experiments. In addition, the possibility of there being serological differences between the two viruses is being investigated.

PHYLLIS B. BLAIR
Department of Zoology and Cancer Research Genetics Laboratory, University of California, Berkeley

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Starch Gel Electrophoresis of Some Invertebrate Sera

An interest in the phylogenic emergence of characteristic serum proteins has prompted us to examine the electrophoretic properties of the blood of several invertebrate forms (*1*).

The method of zone electrophoresis in starch gel described by O. Smithies (*2*) was used to separate serum proteins of fourteen species of decapod Crustacea, two species of Arachnoidea, and two species of Mollusca. Sera from 6 to 12 different specimens of each form were examined. Soluble starch was produced by treatment of potato starch with acetone-HCl (*3*) at 36.1°C for 70 minutes (*4*). Gels were prepared from this soluble starch in 0.030*M* sodium borate buffer of *p*H 9.05, and electrophoresis was carried out at 10°C for 16 hours with a potential of 4.5 v/cm. Members of each species were collected from restricted habitats, with the exception of the green crab. A specimen from waters near Scotland (*5*) gave electrophoretic patterns identical to those of specimens from the Woods Hole region. Within a given species, differences in sex, size, or stages of the molt cycle produced no significant difference in the electrophoretic patterns.

Representative patterns for each form included in the present series are illustrated in Fig. 1; that for a normal human serum is shown at the bottom for comparison and orientation. The cathodic region into which gamma globulins usually migrate is at the left of the origin, while in the human pattern albumin occupies the most prominent and extensive zone in the anodic region. Among the invertebrates studied, there is no indication that serum proteins having electrophoretic properties similar to those of mammalian gamma globulins occur in the serum. Figure 1 also indicates that the serum proteins of these invertebrates are highly species specific above the generic level, although similarities between closely related forms are observed.

From the Arthropoda we have studied, the three species of the fiddler crab (*Uca*) have nearly identical serum electrophoretic patterns. The two species of hermit crab (*Pagurus*) also give patterns which are quite alike. In some cases such similarities might be extended to groupings of families, as demonstrated by the patterns obtained for the calico crab (*Ovalipes*) when compared with those obtained for the green crab (*Carcinides*). An exception, however, is the blue crab (*Callinectes*), the third representative of the family Portunidae which was sampled. This species has practically no similarity to the other two with respect to electrophoretic pattern. This indicates the need for caution in interpreting the significance of the observations thus far obtained in invertebrates correlating morphology with serum protein patterns. A further example of the need for caution in applying this technique to taxonomic problems is indicated by comparing the pattern produced by serum of the lobster (family Homaridae) with the pattern obtained from the serum of the mole shrimp, *Emerita talpoida* (family Hippidae). The two patterns are nearly identical even though the forms are taxonomically in different families.

Comparing the two representatives of

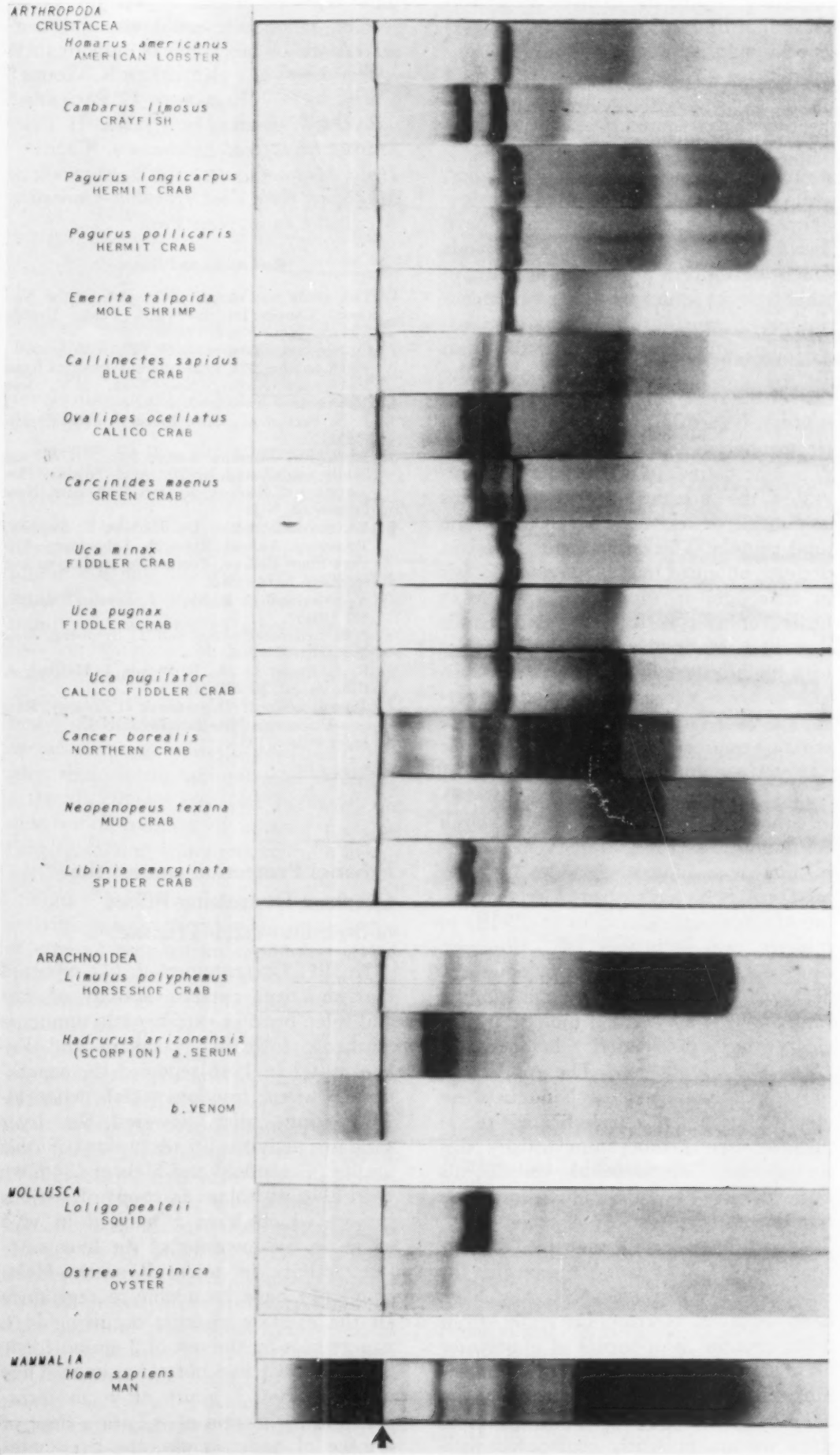

Fig. 1. Starch gel electrophoretic patterns of hemocyanin-containing sera, scorpion venom, oyster serum, and normal human serum. The position at which the samples were applied is indicated by the arrow below the figure. The cathodic area is to the left of the origin, and the anodic area is toward the right.

Arachnoidea cited in Fig. 1, we find that the horseshoe crab (*Limulus*) has quite a different serum protein composition from that of its nearest living relative, the scorpion (*Hadruras arizonensis*) (*6*). Scorpion venom produced a pattern quite unlike scorpion serum, its proteins migrating toward the cathode in a fashion similar to that found in electrophoresis of human gamma globulin.

From the Mollusca we have studied, a species of Cephalopoda and one of Gastropoda are presented here. Serum from the squid (*Loligo pealii*) yielded two major components of moderate mobility, while that from the oyster gave two slow components. No respiratory proteins have been found in oyster blood, and the bands which developed are probably due to other types of serum proteins, the concentrations of which are relatively low.

Hemocyanin is the principal serum protein of many invertebrates, and, in the case of the spiny lobster (*Panulirus interruptus*), it forms a single boundary upon electrophoresis in the Tiselius apparatus (*7*). The boundary method has also revealed the presence of other proteins amounting to less than 3 percent of the total protein. The dense bands found in patterns obtained by zone electrophoresis in starch gel are thus probably due to hemocyanin, even though more bands than one are frequently found. Studies with the ultracentrifuge of the *p*H stabilities of hemocyanins from several different species have demonstrated that these proteins aggregate reversibly near their isoelectric points and yield products of high sedimentation constants ($S_{20}>22$) (*8*). Molecular sieve properties of starch gel might be expected to prevent the admission of such large particles into this medium, as is demonstrated by the failure of some macroglobulins ($S_{20}>19$) to migrate into such gels (*9*). However, since the *p*H of the gel buffer is usually above the alkaline limits of the stability range for the aggregated molecular species, the dissociated hemocyanins ($S_{20}\cong 17$) are observed. The appearance of more than one dense band in these electrophoretic patterns indicates that, at alkaline *p*H, hemocyanins usually dissociate into nonidentical constituents even though the dissociation products have ultracentrifugal homogeneity (*8*). The possibility arises that the copper-containing protein moiety responsible for enzymatic oxygen transport may have been isolated electrophoretically from other protein components of a polymer of higher molecular weight. This possibility should be tested by location of the copper in the electrophoretic patterns since we are presently confronted with the alternative that hemocyanins may distribute copper between more than one dissociation product.

Despite the few exceptions which might prove to have important biological significance, the results of these studies indicate that the electrophoretic patterns of the serum proteins of closely related invertebrates have a remarkable degree of specificity. These findings suggest that starch gel electrophoresis of serum proteins may be useful in certain racial studies, taxonomic problems, and considerations of biochemical individuality.

KENNETH R. WOODS†
ELIZABETH C. PAULSEN*
RALPH L. ENGLE, JR.,† JAMES H. PERT
Marine Biological Laboratory, Woods Hole, Massachusetts, and *Department of Medicine, New York Hospital–Cornell Medical Center, New York*

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* Present address: Department of Zoology, Rutgers University, New Brunswick, N.J.
† Lalor fellow, 1957.

26 August 1957

Ethanol Protection against the Catalase-Depressing Effect of 3-Amino-1,2,4-Triazole

In 1941 Greenstein *et al.* (*1*) reported that the liver catalase activity of rats and mice bearing extrahepatic tumors is markedly lowered. Nakakara and Fukuoka (*2*) in 1948 reported the separation of tumor fractions which, when injected into mice, lowered the liver catalase activity. In extension of this finding, Greenfield and Meister (*3*) have been able to isolate fractions of various tumors which have a marked in vivo effect on the lowering of the liver catalase activity in mice. Recently Heim *et al.* (*4*) have been able to reproduce all the catalase changes occurring in a cancer host by the use of 3-amino-1,2,4-triazole (AT) in a normal animal. They reported that 3 hours after an intraperitoneal injection of AT, in a dose of 1 g/kg of body weight, the liver catalase activity of rats is reduced to 10.9 percent of control values. This depressing effect on catalase activity gradually subsides, and 72 hours after the injection of AT the activity returns to 84.6 percent of control values.

Nelson *et al.* (*5*), while studying the effects of AT on ethanol metabolism, discovered that ethanol, if injected prior to AT, protected the dog from the catalase-depressing effect of AT. One experiment with the rat indicated that the effect was not species specific. It is the purpose of this report to establish the protective action of ethanol in the rat and to report this phenomenon in more detail.

Adult male Sprague-Dawley rats were used throughout the experiments. The animals were allowed free access to Purina laboratory chow and water until the day of the experiment; on this day, food and water were withheld. 3-Amino-1,2,4-triazole (*6*) was injected intraperitoneally as a 10 percent aqueous solution in a dose of 1 g/kg. Ethanol was injected intraperitoneally in a dose of 1 g/kg as a 20 percent (wt./vol.) solution in isotonic saline. Ethanol was injected 1 hour prior to the injection of AT. When isotonic saline was substituted for the ethanol injection, it too was injected 1 hour prior to the injection of AT. At a designated time after the injection, the animal was sacrificed by a blow on the head. A small specimen of liver was removed, washed free of blood, blotted dry, weighed, diluted with nine times its weight of 0.01*M* potassium phosphate buffer (*p*H 6.8), and homogenized in a chilled glass tissue grinder. The 1:10 homogenate was diluted with phosphate buffer to give a final dilution of 1:500. Catalase activity was determined by a modification of the assay procedure of Feinstein (*7*), perborate substrate being used, and is expressed as milliequivalents of sodium perborate destroyed per milligram of liver. Blood ethanol determinations were carried out by the method of Aull *et al.* (*8*).

From the summary of results given in Table 1 it can be seen that, 1 hour following the injection of AT, the catalase activity is reduced to 8.6 percent of control values. At ½ hour after the injection of AT, the catalase activity is 19.8 percent of control values. There appears to be quite a variation in the activity ½ hour following the AT injection, as is shown in the comparatively large standard deviation. It is also shown that if the animal is pretreated with ethanol (1 g/kg) 1 hour prior to the injection of AT, the catalase activity 1 hour following the AT injection is reduced only slightly if at all. Ethanol per se does not affect the catalase activity of the control animals. If the animal is pretreated with a dose of saline (in an amount equivalent to that of saline in a dose of ethanol), no protective action against AT effects is seen.

Table 1. Effect of injections of ethanol, saline, and 3-amino-1,2,4-triazole (AT), alone or in various combinations, on liver catalase activity.

No. of animals	Injection: Ethanol* (g/kg)	Injection: Saline	Injection: AT (g/kg)	Interval between injection and sacrifice (hr)	Catalase activity ± S.D.† (mEq/mg of liver)
4	0	0	0		1.131 ± 0.120
3	1	0	0	2	1.068 ± 0.093
6	0	0	1	0.5	0.224 ± 0.183
4	0	0	1	1	0.097 ± 0.031
3	0	Amt. equal to that in 1 g/kg dose of ethanol	1	1 (after AT)	0.116 ± 0.026
6	1	0	1	1 (after AT)	0.982 ± 0.235

* In saline. † S.D. = standard deviation.

It was decided to determine whether the protective effect of ethanol was permanent or temporary.

In order to determine this, a group of animals was injected with ethanol followed in 1 hour by an injection of AT. Two blood samples were drawn from each rat, the first from 0 to 11 minutes following the AT injection, the second from 60 to 181 minutes following the withdrawal of the first sample. The rat was sacrificed at from 0 to 125 minutes following the withdrawal of the second blood sample. Immediately after the animal was sacrificed, a sample of liver was removed, and the catalase activity was determined. Since the animals were sacrificed at from 60 to 258 minutes following the AT injection, any significant change in catalase activity could not be due to the time interval between AT in-injection and sacrifice. It has been shown (*5*) that, in the rat, 60, 120, 180, and 240 minutes following AT injection, the catalase activity is 13.7, 14.9, 8.7, and 9.6 percent of control values, respectively. Marshall and Fritz (*9*) established that blood ethanol disappearance follows a straight line with time at all blood ethanol concentrations except at low levels (< 10 mg percent), at which levels disappearance follows an exponential curve.

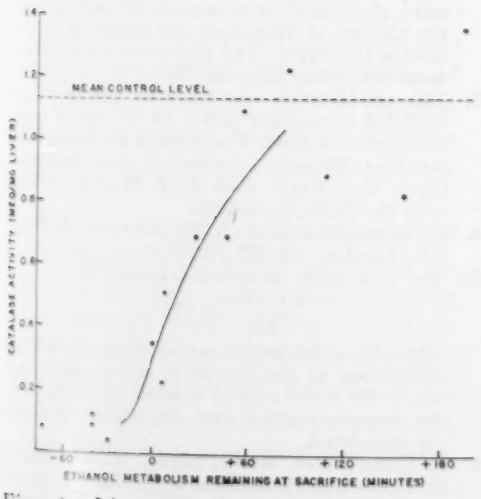

Fig. 1. Liver catalase activity in rats previously injected with ethanol and 3-amino-1,2,4-triazole and sacrificed with varying times of ethanol metabolism remaining.

In view of this, the approximate time at which all ethanol leaves the animal's body may be determined by preparing a graph of the blood ethanol concentrations with time and by extrapolating the blood ethanol line to zero concentration. This was done for each rat, and the number of minutes of ethanol metabolism remaining at the time of sacrifice was determined. If the animal was sacrificed before all ethanol had left its body, the number of minutes of ethanol metabolism remaining is designated by a plus sign. If the animal was sacrificed after all ethanol had left its body, the number of minutes of ethanol metabolism remaining is designated by a minus sign.

Figure 1 shows a plot of the catalase activity against the number of minutes of ethanol metabolism remaining at the time of sacrifice. It can be seen that, approximately 60 to 120 minutes before all ethanol disappears from the animal's body, the AT begins to take effect and the liver catalase activity begins to decrease. The activity falls rather rapidly from the point that represents 60 minutes before all ethanol has disappeared. Within 30 minutes after the disappearance of all ethanol, maximum depressing effects of AT are observed. Perhaps this lag in AT effect is partly or wholly the result of the lag in disappearance of ethanol when low concentrations of blood ethanol are reached. However, as Fig. 1 demonstrates, the ethanol effect is temporary; AT begins to take effect shortly before all ethanol has left the body, and maximum depressing effects are observed shortly after all ethanol has disappeared.

Recently Alexander (*10*) has shown that ethanol reverses the in vitro catalase-depressing effects of an ethanol-soluble boiled aqueous extract (BAE) of normal rat liver. He states that this extract continuously generates H_2O_2, which is decomposed predominantly to oxygen and water in the presence of catalase but with the formation of some inactive catalase-H_2O_2 complex II. This results in decreased catalase activity. When ethanol is present in the system, it removes the H_2O_2 formed and is itself peroxidized to acetaldehyde in the process, thus preventing the accumulation of complex II. In this manner, in the presence of ethanol and ethanol-soluble boiled aqueous extract, catalase activity remains normal. He concludes that the catalatic inhibition of this extract is due to autoxidation of ascorbic acid and sulfhydryl groups in the extract.

The efficiency of ethanol in protecting against the inhibition of AT suggests a mechanism similar to that described by Alexander with ethanol-soluble boiled aqueous extract. However, in the absence of information concerning autoxidation or metabolism of AT, definite conclusions cannot be drawn.

GEORGE H. NELSON
Department of Biochemistry, University of South Dakota Medical School, Vermillion

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7 November 1957

Blocking by Picrotoxin of Peripheral Inhibition in Crayfish

In vertebrates, inhibition takes place within the central nervous system. But a crayfish "thinks in its claws" (*1*). More prosaically, in the Crustacea both excitation and inhibition take place in the peripheral muscle. Because these events are at the fringes of the crayfish body, it is easy to assay drugs for effects on the inhibitory process. The drug we found to block inhibition is picrotoxin (*2*) (which is known to pharmacology for setting off convulsions when injected into a mammal).

The preparation used was the claw of the crayfish, *Orconectes immunis*. The

amputated claw was arranged so that the finger's movement was recorded on a revolving drum. The closer muscle was cut from the finger, and the excitatory and inhibitory nerves to the opener muscle were dissected free and placed on separate stimulating electrodes. The claw was perfused with a buffered modification of van Harreveld's crayfish Ringer's solution (*3*). Picrotoxin, when used, was dissolved in the Ringer's solution.

One way in which we recorded inhibition was by stimulating the excitatory nerve tetanically until a contraction was well developed and by then briefly stimulating the inhibitory nerve as well. During the stimulation of the inhibitory nerve, the contraction decreased (Fig. 1, IA). After the claw had been perfused with picrotoxin solution (Fig. 1, IB), the contraction was no longer affected by stimulation of the inhibitory nerve.

Inhibition was also seen when the excitatory nerve and the inhibitory nerve were stimulated together at the outset (Fig. 1, IIA). With this method there was either no contraction, showing that the inhibition was complete (as in the illustration), or the muscle contracted at a rate slower than normal, showing that the inhibition was partial. The extent of the inhibition depended on the ratio of the frequency of inhibitory nerve stimulation to the frequency of excitatory nerve stimulation (*4*). After perfusion with picrotoxin, the muscle responded to concurrent stimulation of the excitatory and inhibitory nerves as if the excitatory nerve alone had been stimulated (Fig. 1, IIB). Picrotoxin had blocked inhibition.

The extent to which inhibition was blocked depended on the concentration

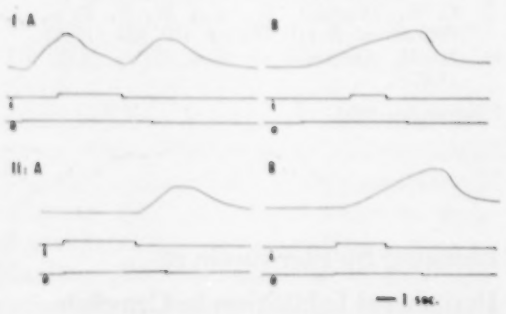

Fig. 1. The effect of stimulating the excitatory (e) and inhibitory (i) nerves running to the opener muscle of the crayfish claw. An upward deflection of the signal trace indicates that the nerve was stimulated at a rate of 60 stimulations per second. (IA) Stimulation of the inhibitory nerve during the contraction caused by stimulating the excitatory nerve; (IB) same as IA, but 30 minutes after the perfusion of $10^{-4}M$ picrotoxin; (IIA) initial simultaneous stimulation of the excitatory and of the inhibitory nerves; (IIB) same as IIA, but after the perfusion of picrotoxin.

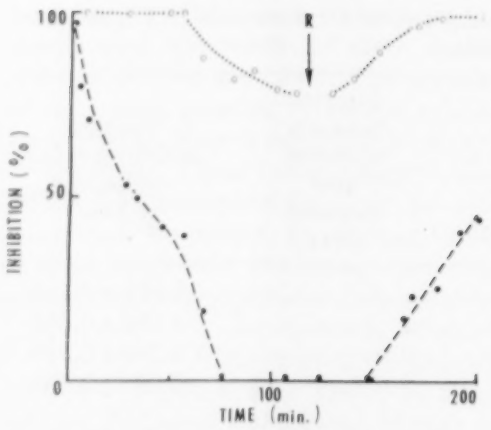

Fig. 2. The percentage inhibition at intervals following the onset of perfusion of $10^{-4}M$ picrotoxin. The excitatory nerve was stimulated at a rate of 60 stimulations per second. The inhibitory nerve was simultaneously stimulated at a rate of 21 stimulations per second (dotted line) or at 150 stimulations per second (broken line). At the time indicated by *R*, perfusion of picrotoxin was stopped and perfusion with Ringer's solution was begun.

of picrotoxin. Picrotoxin ($10^{-6}M$) had almost no effect, while higher concentrations progressively decreased the effect of inhibitory nerve stimulation. The action of picrotoxin was almost independent of *p*H over the range tested (from *p*H 6.3 to *p*H 7.7).

The time course of the action of picrotoxin was determined by stimulating both the excitatory and inhibitory nerves at intervals after the onset of picrotoxin perfusion. The percentage inhibition was measured from the record (*5*). One experiment was plotted as shown in Fig. 2. Originally the contraction was completely inhibited when the inhibitory nerve was stimulated at rates of either 21 or 150 stimulations per second. Soon after picrotoxin was introduced, inhibitory nerve stimulation at a rate of 21 per second produced no inhibition, while stimulation at 150 per second gave only partial inhibition. The graph also shows that the effect of picrotoxin was eliminated by washing the drug out of the claw.

The mechanism of picrotoxin action was then investigated. It was evident that picrotoxin does not act by selectively blocking the conduction of nerve impulses along the inhibitory nerve, for inhibition was normal after the nerve had been soaked in picrotoxin, so long as the muscle was free of the drug. And the excitatory mechanism was not interfered with, for it remained normal long after the muscle and the nerves were exposed to picrotoxin.

The analysis may be carried further by assuming that the inhibitory nerve releases an inhibitory transmitter at its ending. Picrotoxin might block inhibition by slowing the release of the inhibitory transmitter or by affecting some later step in the inhibitory mechanism—for example, by blocking the combination of the inhibitory transmitter with a receptor molecule. It seems unlikely that picrotoxin slows the release of the inhibitory transmitter, because Florey, McLennan, and Elliott have shown that the crayfish stretch receptor and the crayfish muscle can be inhibited by a chemical from the mammalian brain, and that this chemical's inhibitory action on the stretch receptor is blocked by picrotoxin (*6*). And our data are also consistent with the idea that picrotoxin blocks the combination of the inhibitory transmitter with a receptor molecule.

It may be concluded that picrotoxin reversibly blocks peripheral inhibition in crayfish muscle. Probably picrotoxin joins with the receptor molecule and thereby blocks the action of the inhibitory transmitter; that is, picrotoxin appears to have a "curarelike" action on this inhibitory synapse. Perhaps the convulsions and central nervous system excitation produced when picrotoxin is injected into a mammal are caused by a similar mechanism.

WILLIAM G. VAN DER KLOOT
Department of Zoology, Cornell University, Ithaca, New York

JAY ROBBINS
College of Physicians and Surgeons, Columbia University, New York, New York

IAN M. COOKE
Biological Laboratories, Harvard University, Cambridge, Massachusetts

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3. This modification was made by adding 55 ml of 0.2*M* trismaleate buffer to 945 ml of crayfish perfusion fluid. The crayfish perfusion fluid was the Ringer's solution of van Harreveld [*Proc. Soc. Exptl. Biol. Med.* 34, 428 (1936)] with the $NaHCO_3$ omitted.
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5. The percentage inhibition is defined as:
$$\frac{C_e - C_{ei}}{C_e} \times 100$$
where C_e is the initial rate of contraction with stimulation of the excitatory nerve alone and C_{ei} is the initial rate of contraction when both the excitatory nerve and the inhibitory nerve are stimulated.
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14 October 1957

Book Reviews

Industry and Technical Progress. Factors governing the speed of application of science. C. F. Carter and B. R. Williams. Oxford University Press, London, 1957 (order from Oxford University Press, New York). viii + 244 pp. $4.

One of the most difficult of man's tasks is keeping a perspective on the "present"—remembering how much the present depends on the past and how little the future will resemble the present. C. F. Carter and B. R. Williams have tried to develop some of this perspective with regard to the role of science and scientific personnel in British industry.

In this task, the authors seem to have steered a wise course. Rather than supply answers, they have tried to present the major problems of effective utilization of science and scientific personnel, in the circumstances and current traditions of British industry, in the context of that industry's present economic, social, and political environment. In presenting these problems in this frame of reference, they also expose the fallacies of many simple panaceas which are proposed from time to time.

As in most problems of this size, it turns out that an evolution, rather than answers, seems to be required for substantial improvements—an evolution involving large segments of a country's human resources: management, scientists, teachers, government employees, and so on. Members of each of these segments must learn more about the problems and about the roles they can play in the segments. *Industry and Technical Progress* can serve this required orientation function quite well.

I find one major disquieting over-all note in the book. It seems tacitly to assume that the way to technical progress will be through profit motives of industry. This assumption seems closely akin to the largely discredited "theories of the firm," based solely on economic concepts, for describing the activities of companies. It appears, more and more, that economic concepts alone are not adequate in considering industrial companies and that consideration of elements of political and social behavior is also required. And, with regard to technical progress, man's simple but God-given scientific curiosity would seem much too important a factor to be overlooked. I would put it to the authors that the driving force behind individuals in large company research organizations is still simple curiosity—and that technical innovations result to a much greater extent out of this curiosity than out of commercial pressures.

HARLAN D. MILLS
Princeton University

Principles of Engineering Geology and Geotechnics. Geology, soil, and rock mechanics, and other earth sciences used in civil engineering. Dimitri P. Krynine and William R. Judd. McGraw-Hill, New York, 1957. xiii + 730 pp. Illus. $10.

The appearance of an engineering text with the word *geotechnics* in its title is a healthy sign of the steady development of earth studies by engineers. Much as professional engineers dislike the word *technology* (and its derivatives) when applied to their work, they have generally welcomed the use of *geotechnics*, in view of its obvious advantages. It has a direct French equivalent ("*Geotechnique*" having already been adopted as the name of an international journal in this field); it has a useful parallel in the word *geophysics*; and it is succinctly descriptive of the study of the engineering uses to which the materials that constitute the earth's crust are put. It is this field that is treated in the volume under review.

The volume is a veritable storehouse of information, indicative of the senior author's lifetime of experience and of the use by the junior author of some of the accumulated corporate experience of the U.S. Bureau of Reclamation, where he serves as engineering geologist on the staff of the chief engineer. The book is well illustrated and well indexed, being up to the usual high standard of McGraw-Hill volumes from the standpoint of production.

Readers of *Science* will want to know the audience for whom this volume is intended. A detailed study of its contents, made in an attempt to determine this, leads to somewhat puzzling results. The book is far too large and diffuse to serve as a college textbook. As the authors themselves state, "case histories have been used only for the elucidation of principles," and this is therefore not a collection of case histories of the type that can be so valuable an aid to the practicing, as also to the embryo, engineer. And as a reference book it has the unfortunate feature of merely directing the reader to another reference on all too many important topics.

So much work has clearly gone into the preparation of the book that one regrets being unable to give it unqualified praise. With the mounting volume of technical literature, however, such a collection of undigested material—useful though the lists of individual references are—is not as helpful as it might be. The arrangement of the book is a fair indication of the additional attention in assembling and pruning of contents that it so clearly needs. Seven of the 19 chapters, for example, deal successively with "Subsurface Exploration," "Maps and Airphotos," "Rock as a Construction Material," "Tunnels," "Frost and Permafrost," "Shore-line Engineering and River Improvement," and "Elements of Sedimentation Engineering [sic]." If there is order or logic in this arrangement, it has escaped my attention.

As a useful guide to current American literature in the field of geotechnics, the book can be highly commended. At the same time, it can serve as a telling example of the fact that, in order to be fully effective, a good book requires something more than the collection between two covers of a vast quantity of factual information, useful and interesting though this may be.

ROBERT F. LEGGET
Division of Building Research, National Research Council, Ottawa, Ontario

Medical Radiation Biology. Friedrich Ellinger. Thomas, Springfield, Ill.; Blackwell, London; Ryerson, Toronto, 1957. xxxiv + 945 pp. Illus. $20.

Medical radiation biology is defined by the author as comprising clinical radiation biology and experimental radiation therapy. However, this book can in no sense be described as a text on radiation therapy. It is rather a book in which the author intends to compile "the rationale on which the role of radiation as a health hazard and as a therapeutic agent is based."

The book, with some 4600 references

occupying one-fourth of the 950 pages, is divided into four parts: (i) fundamental radiation biology; (ii) biology of ionizing radiations; (iii) biology of ultraviolet radiation; and (iv) photobiology. There are numerous textual references to the bibliography, but the usefulness of the volume as a reference work is limited by the absence of an index.

A comprehensive review of the gross and microscopic effects of radiation on each organ system is presented. This extensive pathophysiologic discussion is amply documented by carefully selected references to articles published in the English, French, and German languages.

For one author to attempt a review and critical summary of the extensive fields outlined above is indeed an ambitious project. Certainly the treatment of specialized subjects will not satisfy the expert in the field. The book's usefulness must therefore lie in its attempt to serve as an introduction to radiobiology and as a link between fields in radiobiology.

Surgeons and internists, not to mention radiotherapists, will pause at the sentence, "for the general public radiation therapy and treatment of cancer are almost synonymous." In the discussion of the radioactive iodine (I^{131}) therapy for hyperthyroidism, there are several errors, not the least of which are two errors in the formula to be used for calculation of the number of millicuries of radioactive iodine required to deliver a certain radiation dose to the thyroid.

In summary, this volume by a mature and forthright clinician and investigator may be useful to the experienced radiologist who wishes a survey, simply presented, of the field of radiobiology. It is not recommended for those uninitiated in the fundamentals of radiation physics or radiobiology, or both.

J. L. STEINFELD
National Institutes of Health

Parthenogenesis and Polyploidy in Mammalian Development. Cambridge Monographs in Experimental Biology No. 7. R. A. Beatty. Cambridge University Press, New York, 1957. xi + 132 pp. Illus. $3.

R. A. Beatty of the department of animal genetics of the University of Edinburgh has given us a very complete and critical account of parthenogenesis and heteroploidy in mammals. He is uniquely qualified for this task, for several reasons: together with M. Fischberg, now at Oxford, he has made a thorough investigation of spontaneous and induced heteroploidy in eggs and embryos of mice; in 1954 he published [*Intern. Rev. Cytol.* **3** (1954)] a lucid review under the title "How many chromosomes in mammalian somatic cells?", which summed up our knowledge of the real and, in some cases, spurious inconstancy of somatic chromosome numbers; last, but not least, he is probably the only mammalian cytologist who has had the enterprise to count his own chromosomes, in dividing cells of a hair follicle (I believe he found 48—or was it 46?).

The author places the primary emphasis on the "cytological variables" which furnish the known or surmised mechanisms of origin of the various observed or theoretically expected chromosome numbers. The principal variables are the suppression of the first or second meiotic division in the egg, or of the first cleavage mitosis, either with or without fertilization of the egg (amphimictic versus apomictic routes). In consideration of the various possible combinations of these variables, the material is classified in chapters 3, 4, and 5 under the headings "The eight apomictic routes in the major group," "The eight amphimictic routes in the major group," and "A minor group of routes of development." This treatment is logical but tends to make the organization of the material unnecessarily complicated, since the actual route which gave rise to some abnormal chromosome numbers is often not known with certainty. It might have been preferable to classify the various cases first according to chromosome number and then to subdivide these primary categories into secondary classes on the basis of the known or probable mode of origin.

A few omissions or inaccuracies should be mentioned. The paper by Ursula Jahn (1952) on colchicine-induced tetraploidy in *Rana esculenta* (which appears to be connected with gigantism, in contrast to all other observations on polyploid amphibia) is not mentioned; the study by A. A. Humphries (1956) on the occurrence of abnormal meiotic divisions in untreated coelomic or oviducal eggs of *Triturus viridescens*, which demonstrates the probable origins of spontaneous polyploids in this species, probably appeared too late to be considered. The term "poikiloploidy" mentioned on page 6 was first used by Levy (1920) to designate the occurrence of different abnormal chromosome numbers within the same embryo. The statement (page 9) that, "in amphibians, an *inverse* proportion exists between cell or nuclear volume and the number of chromosome sets" is obviously wrong, as is the assertion that the number of heterochromatic spots, important in determining the number of chromosome sets in tissues of some insects, has been used for the same purpose in amphibians by Fankhauser and Humphrey (1943); we used the number of nucleoli exclusively.

In chapter 6 Beatty discusses some general aspects of parthenogenesis and polyploidy in mammals. These include (i) the debated role of polyploidy in mammalian evolution; (ii) the question of whether polyploid mammalian fetuses are viable (so far no polyploid mouse embryos have ever been found after midterm); (iii) the question of whether spontaneously parthenogenetic mammals ever come to term and could be identified (which the author thinks highly improbable); (iv) some specific genetic aspects of parthenogenesis and polyploidy, such as gene dosage; (v) sex determination and fertility in polyploids; and (vi) their size and growth rate.

Beatty's book will be an important guide for all those who are interested in developmental genetics and the cytology of mammals and will stimulate many new experiments in this fascinating and relatively new field.

G. FANKHAUSER
Princeton University

The Fascination of Numbers. W. J. Reichmann. Essential Books, Fair Lawn, N.J., 1957. 176 pp. $4.

The theory of numbers is a many-sided mathematical theory, but first and foremost it is concerned with the properties of the integers 1, 2, 3, 4. . . . It is a fascinating theory; it has some problems which are so easy to formulate that an intelligent youngster in the eighth grade can fully understand them but so difficult to solve that the united effort of the greatest mathematicians of the last three centuries was unable to master them. The integers may have a singular attraction for an exceptionally gifted youngster and open his mind to science. Therefore, it is to be deplored that divisibility, prime numbers, and similar topics are almost completely neglected by our high schools (they are taught in the corresponding European schools). Under these circumstances a good popular book dealing with these topics would be highly welcome.

The present book deals with such topics, but, unfortunately, in my opinion, it does not fulfill the great promise of the subject matter. The sequence in which the topics are treated seems almost random. The difference between inductive evidence and strict proof is nowhere emphasized; both are often omitted without warning, but the worst of it is that neither is really neatly presented. Little previous knowledge is asked from the reader, and that is right; but there are a few pages, some right in the middle of the book, where the reader is sud-

denly supposed to understand logarithms or trigonometry or infinite series, or infinite continued fractions. There are a few incorrect assertions, some disconcerting typographical errors, and a few places where the author misapplies the simplest mathematical terms, such as *equation* or *identity*.

G. POLYA

Stanford University

Neutron Cross Sections. Donald J. Hughes. Pergamon, London and New York, 1957. x + 182 pp. Illus. $5.

Neutron Cross-Sections, by D. J. Hughes, is a monograph devoted to assisting people who do not have training in nuclear theory and who must use cross sections. As director of the neutron cross-sections compilation work at Brookhaven Laboratory, Hughes was in an excellent position to judge what terms caused nonphysicists the most trouble. The first chapter of the book is devoted to introducing the reader to the language of neutron physics by use of the terms in context; this monograph is not a dictionary.

The second chapter is devoted to the nomenclature employed by theoretical physicists in developing models to explain and correlate the experimental data. This chapter is a very nice demonstration of Hughes' ability as a writer to cover a complex subject concisely and simply.

In the last four chapters Hughes acquaints the reader with some of the details of specialized areas of neutron physics.

Those working in the fields of differential cross sections and inelastic scattering cross sections will probably regret that the author does not make a greater effort to clarify terminology in these areas.

A. WATTENBERG

Laboratory for Nuclear Science, Massachusetts Institute of Technology

Natural Magick. A volume in *The Collector's Series in Science.* John Baptista Porta. Derek J. Price, Ed. Basic Books, New York, 1957. ix + 419 pp. Illus. $7.50.

To penetrate the mystery of the rise of "modern science" in the 16th and 17th centuries, it is not enough to know something of Copernicus, Galileo, and the other giants. The republication of Porta's book (edition of 1658)—long a guarded treasure of the rare-book rooms of libraries—offers a pleasant and profitable tour through what the editor calls the "plain-lands" of early science, from which these giants sprang. This work is typical of a vast forgotten literature, best described in modern terminology as popular encyclopedias of the arts and sciences. Porta was no hack writer, however, but a competent, if not a profound, natural philosopher whose contributions to science were not insignificant. He was instrumental in founding the first modern "academy of science" (the Accademia Secretorum Naturae), and its proceedings are reflected in the present book.

The volume is attractively bound and boxed. The reproduction of the archaic type face of the original is a questionable advantage, but no great obstacle to the enjoyment of what may best serve as a sort of scientists's bedside book. According to his mood, the reader can sample the science and lore of magnetism before Gilbert or of optics before the telescope and microscope; or he can peruse relatively lucid accounts of the transmutation of metals or of the "new" fad in chemistry—distillation. In a lighter mood, he can discover how women were beautified in these centuries, or how secret communications were accomplished. Anyone interested in the history of science, or in history at all, can find profit and enjoyment in this book.

ROBERT MULTHAUF

Smithsonian Institution

Reptiles Round the World. A simplified natural history of the snakes, lizards, turtles, and crocodilians. Clifford H. Pope. Knopf, New York, 1957. xv + 204 pp. Illus. $3.50.

The author, well-known for previous herpetological works, both technical and semipopular, has prepared this new book with the younger generation in mind—the boys and girls whose interest in nature is beginning to be centered on a particular branch of natural history.

The professional scientist always faces a serious task in undertaking a book of this kind. Almost never is there a question of knowledge of the subject; the problem is one of presenting the subject in abbreviated and simplified form, yet in so well-balanced and attractive a manner as to encourage the young reader into expanding his field observations and studies. In this respect Pope has succeeded admirably. The book is interesting and instructive, and the facts regarding the several groups of reptiles are presented in the orderly manner so necessary for supplying the young reader with a basic understanding of the extent of the several groups and the subdivisions within them. Technical terms are largely avoided, as are the restrictions of taxonomy, since discussions are seldom carried below the generic level.

The subject is treated from two major viewpoints: first, there are chapters on the different features of reptile life, such as locomotion, food, reproduction, size, growth, enemies, and habits; these are followed by a survey of the distribution, by continents, of each major group. The discussions are illustrated by many attractive sketches by Helen Damrosch Tee-Van.

This book can be recommended as a foundation upon which the budding herpetologist can build his further studies. Among other sound advice, it even contains a word of caution to the youngster of exhibitionist tendencies who aspires to make a career of handling snakes before shocked but fascinated audiences (mostly female). The museums and zoos requiring herpetological curators are too few to supply a livelihood for more than a fraction of these aspirants; besides which, the duties of herpetological curators almost never involve such spectacular but nonscientific exploits.

LAURENCE M. KLAUBER

San Diego Museum of Natural History, San Diego, California

New Books

The Frogfishes of the Family Antennariidae. No. 3383, Proceedings of the U.S. National Museum, vol. 107. Leonard P. Schultz. Smithsonian Institution, Washington, D.C., 1957. 58 pp.

Discovery. No. 2, 1957. University of Melbourne. Melbourne University Press, Carlton, N.3, Victoria, 1957. 96 pp. 2s. 6d.

International Sanitary Regulations. Adopted by the Fourth World Health Assembly in 1951 and amended by the eighth and nine assemblies in 1955 and 1956. Annotated edition. World Health Organization, Geneva, 1957 (order from Columbia University Press, New York). 127 pp. $1.

Four Basic Aspects of Preventive Psychiatry. Report of the First Institute on Preventive Psychiatry held at the State University of Iowa, 3 Apr. 1957. Ralph H. Ojemann, Ed. State University of Iowa, Iowa City, 1957. 122 pp. $2.

The Biology and Systematics of the Pinfish, Lagodon Rhomboides (Linnaeus). Bulletin of the Florida State Museum, Biological Science, vol. 2, No. 6. David K. Caldwell. University of Florida, Gainesville, 1957. 98 pp. $1.25.

Handbuch der Physik. vol. XVI, *Electric Fields and Waves.* S. Flügge, Ed. Springer, Berlin, 1958. 760 pp. DM. 158.

Metabolism of the Nervous System. Derek Richter. Pergamon Press, New York and London, 1957. 613 pp. $16.

Queues, Inventories and Maintenance. The analysis of operational systems with variable demand and supply. Philip M. Morse. Wiley, New York; Chapman and Hall, London, 1958. 211 pp. $6.50.

Meetings and Societies

Program of the Gordon Research Conferences

The Gordon Research Conferences for 1958 will be held from 9 June to 29 August at Colby Junior College, New London, N.H.; New Hampton School, New Hampton, N.H., and Kimball Union Academy, Meriden, N.H.

Purpose. The conferences were established to stimulate research in universities, research foundations, and industrial laboratories. This purpose is achieved by an informal type of meeting consisting of scheduled lectures and discussion groups. Sufficient time is available to stimulate informal discussions among the members of a conference. Meetings are held in the morning and in the evening, Monday through Friday, with the exception of Friday evening. The afternoons are available for recreation, reading, or participation in discussion groups, as the individual desires. This type of meeting is a valuable means of disseminating information and ideas to an extent that could not be achieved through the usual channels of publication and presentation at scientific meetings. In addition, scientists in related fields become acquainted and valuable associations are formed that often result in collaboration and cooperative efforts between different laboratories.

It is hoped that each conference will extend the frontiers of science by fostering a free and informal exchange of ideas among persons actively interested in the subjects under discussion. The purpose of the program is not to review the known fields of chemistry but, primarily, to bring experts up to date on the latest developments, to analyze the significance of these developments, and to provoke suggestions concerning the underlying theories and profitable methods of approach for making new progress.

In order to protect individual rights and to promote discussion, it is an established requirement of each conference that no part of the information presented is to be used without specific authorization of the individual making the contribution, whether in formal presentation or in discussion. Scientific publications are not prepared as emanating from the conferences.

Registration and reservations. Attendance at the conferences is by application. Individuals interested in attending the conferences are requested to send their applications to the director at least 2 months prior to the date of the conference. *All applications must be submitted on the standard application form,* which may be obtained by writing to the office of the director. This procedure is important because certain specific information is required in order that a fair and equitable decision on the application may be made. Attendance at each conference is limited to approximately one hundred individuals.

The director will submit the names of those requesting authorization to attend the Conference Committee for each conference. This committee will review the names and select the members in an effort to distribute the attendance as widely as possible among the various institutions and laboratories represented. A registration card will be mailed to those selected, as soon as possible. Advance registration by mail for each conference is required, and registration is completed on receipt of the card and a deposit of $15 (checks are to be made payable to the Gordon Research Conferences). The deposit of $15 will be credited against the fixed fee for the conference if the individual attends the conference for which he has applied. A registration card not accompanied by the $15 deposit will not be accepted.

The board of trustees of the conferences has established a fixed fee of $100 for each conference. This fee was established to encourage attendance for the entire conference and to increase the special fund that is available to each conference chairman for the purpose of assisting conferees who attend a conference at total or partial personal expense with their travel or subsistence expenses, or with both. This fixed fee will be charged regardless of the time a conferee attends the conference—that is, for periods of from 1 to 4½ days. It is divided as follows: registration fee, $40 ($15 for administration and $25 for the special fund); room and meals, $60 (including gratuities), for 5 days. An additional charge of $1 per night per person will be made for a room with private bath or for a single room, of which there are a limited number available. These rooms will be assigned in the order that applications are received.

Members attending a conference are expected to live at the conference location because one of the objectives of the conferences is to provide a place where scientists can get together informally. It is to the advantage of all participants to attend a conference for the entire week. If special circumstances warrant living elsewhere, a registration fee of $50 is charged.

The fixed fee will cover registration, room (except room with private bath or single room), meals, and gratuities. It will not provide for golf, telephone, taxi, laundry, conference photograph, or any other personal expenses.

Conferees on total or partial personal expense who are living at the conference location, may request a reduction of $25 (the amount allotted for the special fund) in the fixed fee. Application for this special fee ($75) must be made when the registration card is returned to the director.

Accommodations are available for a limited number of women to attend each conference, and also for wives who wish to accompany their husbands. All such requests should be made at the time the attendance application is submitted, because these accommodations, limited in number, will be assigned in the order that specific requests are received. Children under 12 years of age cannot be accommodated. Dogs or other animals will not be permitted in the dormitories.

Special fund. The special fund is provided for by the board of trustees from the registration fees and is made available to the chairman of each conference for the purpose of assisting scientists from academic and government institutions who could not otherwise attend or participate because of financial limitations. This fund is provided with the object of increasing the participation of research workers from academic and government laboratories; its use is not limited to scientists who have been invited by the chairman to attend a conference in order to present a paper. The money is to be used as an assistance fund only and may be used to contribute toward traveling expenses or subsistence expenses at the conference, or both. Total travel and subsistence expenses will not usually be provided.

Cancellations. The cancellation of an approved application for attendance at a conference will cause forfeiture of the $15 deposit.

Attendance. Requests for attendance at the conferences or for additional information should be addressed to W. George Parks, Director, Department of

Chemistry, University of Rhode Island, Kingston, R.I. From 9 June to 29 August, mail should be addressed to Colby Junior College, New London, N.H.

Colby Junior College

Petroleum

Phillip D. Caesar, *chairman*
George H. Denison, *vice chairman*

9–13 June. R. E. Kallio, "Microbial oxidation of hydrocarbons"; W. H. Bauer, "Oxidation of boranes"; P. S. Bailey, "Mechanisms of ozonolysis of hydrocarbons"; H. G. Wolfhard, "The physics and chemistry of combustion"; R. J. Gordon, "Application of a single molecular orbital model to combustion reactions"; E. B. Rifkin, "New advances in the chemistry and physics of antiknock action"; Andrew Fono, "Homolytic reactions induced by metal salts"; Joseph Weiss, "Radiation induced oxidation of hydrocarbons"; Glen A. Russell, "Fundamental processes in autoxidation of hydrocarbons."

Separation and Purification

Lyman C. Craig, *chairman*
Edmond S. Perry, *vice chairman*

16 June. Joel H. Hildebrand, "What solubility theory has to offer"; J. L. Torgesen, "The retention of impurities by growing crystals"; H. L. Meltzer, "Three phase countercurrent distribution."

17 June. W. E. Henderson, "Separations by filtration through membranes"; O. Smithies, "Zone electrophoresis in starch gels"; K. Hickman, "Recovery of water."

18 June. H. A. Sober, "Chromatography with columns of modified cellulose"; M. A. Mitz, "Effect of CO_2 on chromatograms with modified cellulose"; A. T. James, "Vapor-liquid chromatography."

19 June. D. F. Peppard, "Mechanism of extraction of metallic cations by acid esters of orthophosphoric acid"; B. S. Weaver, "Separation of rare earths by liquid-liquid extraction."

20 June. W. Greiner, "A commercial countercurrent solid-liquid extraction process"; M. W. Fogle and C. C. DeWitt, "An engineering approach to the separation of amino acids."

Catalysis

Vladimir Haensel, *chairman*
R. P. Eischens, *vice chairman*

23–27 June. H. L. Pickering and H. C. Eckstrom, "Infrared studies of adsorbed species on evaporated metal films"; J. Halpern, "Homogeneously catalyzed reactions of molecular hydrogen in solution"; D. E. O'Reilly, "Nuclear magnetic resonance studies of catalytic solids"; T. R. Hughes, R. J. Houston, and R. P. Sieg, "Carbon monoxide chemisorption on supported metal catalysts by radiotracer measurements in a flow system"; G. Parravano, "Oxygen affinities of metal catalysts"; G. S. John and R. J. Mikovsky, "Average properties of fluidized catalysts"; F. C. Tompkins, "Chemisorption and catalysis"; Herman Pines, W. O. Haag, and Gaston Benoy, "Alumina—a catalyst and a support"; H. Kloosterziel, "Hydrogen-deuterium exchange and redistribution reactions of hydrocarbons on solid catalysts."

Polymers

T. G. Fox, *chairman*
F. R. Eirich, *vice chairman*

30 June. H. Mark, "Recent advances in polymer chemistry"; C. Sadron, "Recent research in the Centre de Recherches sur les Macromolecules of Strasbourg"; J. C. W. Chien, "Kinetics of ethylene polymerization by soluble organotitanium-aluminum catalysts."

1 July. A. Korotov, "Kinetics and mechanism of polymerization of vinyl monomers by metallo-organic compounds"; J. W. L. Fordham, "Stereoregular polymers from free radical initiators"; J. R. Schaefgen, "Laterally ordered polymers."

2 July. W. Slichter, "NMR studies of some stereospecific polymers"; W. R. Krigbaum, "Thermodynamics of the polystyrene-cyclohexane system near the Flory theta temperature."

3 July. E. L. Wittbecker, "Interfacial polycondensation"; P. W. Morgan, "Fundamentals of interfacial polycondensation"; W. Kern, "The importance of uniformity of structure in macromolecular chemistry."

4 July. R. K. Graham, "The synthesis and characterization of graft copolymers"; Y. Landler, "Physical and mechanical properties of some graft copolymers obtained by preozonization."

Textiles

Emery I. Valko, *chairman*
Leonard Smith, *vice chairman*

7 July. H. Mark, "Deformation mechanism of polymers"; Norman J. Abbott and Freddy Khoury, "Tenison changes in textile structures during wetting and drying."

8 July. W. A. Sisson, "The structure and properties of viscose rayons"; R. E. Seaman and J. C. Shivers, "Elastic textile fibers based on condensation polymers."

9 July. C. M. Conrad, "Relationships between mechanical behavior and chemical modification of cotton"; Helmut Zahn, "Some new results in wool chemistry."

10 July. A. A. Burgeni and E. V. Painter, "Movement of fluids in fibrous beds: capillary sorption, permeation"; F. W. Minor, L. C. Buckles, E. Wulkow, and A. M. Schwartz, "The transport of liquids in textile assemblies."

11 July. C. Schlatter, "Mechanism of fiber and yarn lubrication."

Corrosion

Joseph E. Draley, *chairman*
P. M. Aziz, *vice chairman*

14–18 July. The nature of metal surfaces: H. Juretschke, "The atomic nature of metal surfaces"; C. S. Smith, "Metallography and corrosion." *Adsorption on metals*: J. T. Law, "The adsorption process on semiconductors"; L. S. Bartell, "Optical studies of adsorption from solution"; R. T. Gomer, "Field and ion emission microscopy"; P. W. Selwood, "Magnetization and surface chemistry." *Oxides on metals*: J. V. Cathcart, "The microtopography of oxide films on metals"; Jerome Kruger; "The growth of oxide films on copper in water containing oxygen"; W. D. Feitknecht, "Chemistry of the corrosion products formed on Cu, Cd, Zr, and Fe in aqueous solutions"; E. A. Gulbransen, "Crystal habits in localized corrosion and oxidation processes in relation to metal structure." *Electrode reactions*: J. O'M. Bockris, "The mechanism of anodic dissolution of metals and the inhibition of corrosion." *Passivity*: Review of Darmstadt passivity colloquium and general discussion on passivity mechanisms.

Vitamins and Metabolism

Lemuel D. Wright, *chairman*
Harry P. Broquist, *vice chairman*

21 July. Klaus Schwarz, "The factor 3 potencies of selenium compounds in dietary liver necrosis and in other deficiencies"; M. L. Scott and M. C. Nesheim, "Selenium as a nutrient for chicks"; E. L. R. Stokstad and R. G. Eggert, "Role of vitamin E and selenium in the nutrition of the pig"; Lester J. Reed, "Nature and reactions of protein-bound lipoic acid"; David E. Metzler, "Catalysis of pyruvate decarboxylation by thiamine and thiamine analogs."

22 July. Victor W. Rodwell, Miyoshi Ikawa, Benjamin E. Volcani, and Esmond E. Snell, "The bacterial oxidation of pyridoxine"; Sidney Weinhouse, "Factors influencing entry and removal of blood glucose"; John Spizizen, "Metabolism of viruses"; Boris Magasanik, "Histidine biosynthesis"; H. Waelsch, A. Neidle, and D. D. Clarke, "Amine metabolism."

23 July. G. Popjak, J. W. Cornforth, R. H. Cornforth, J. Gosselin, R. G. Gould, I. Youhotsky-Gore, and A. de Waard, "Biosynthesis of squalene and sterol from mevalonic acid"; T. T. Tchen, "The earlier stages of steroid biogenesis"; E. Kodicek, "Studies on sterols in microorganisms"; David B. Sprinson, P. R. Srinivasan, and J.

Rothschild, "The metabolic reactions between glucose and aromatic compounds"; D. W. Woolley, "Serotonin"; Byron E. Leach, Robert G. Heath, and Mathew Cohen, "Studies with taraxein."

24 July. June Lascelles, "Factors involved in the synthesis of porphyrins and related pigments by microorganisms"; Peter B. Danneberg, "Chemotherapeutic studies with fluorinated pyrimidines"; Samuel Bieber, "Uracil antagonists and tumor inhibition"; Howard A. Schneiderman, "Chemistry and physiology of insect hormones"; Hugh S. Forrest, "Metabolic reactions of biopterin."

25 July. J. R. Couch, "Mineral metabolism in the avian species"; James S. Dinning, "The role of vitamins C and B_{12} in one-carbon metabolism"; N. W. Flodin, "Amino acid fortification."

Instrumentation

N. B. Nichols, *chairman*
Clifford E. Berry, *vice chairman*

28 July–1 Aug. Invited papers. William A. Baum, "Image tubes and their astronomical applications"; Philip G. Gilman, "Automatic data logging"; John H. Heller, "Challenging problems in medical and biological instrumentation"; P. C. Hoell, "Electron beam dosimetry"; C. Lester Hogan, "Masers"; R. N. Lane, "Solions"; Marcus O'Day, "Worth-while rediscoveries from 100 years ago"; H. I. Schiff, "The use of the mass spectrometer in studying free radicals and other short-lived species."

Contributed papers. R. P. Bigliano, "Analog computers as process control elements"; Erik Blomgren, "Some new principles and devices for the study of electrochemical phenomena"; W. M. Flook, "New instrument developments"; A. S. Iberall, "Some transfer functions of the human in a control situation"; Joseph M. Kime, "An indoor coefficient of restitution tester for golfballs and baseballs"; Sidney Lees, "A physical basis for control system dynamics"; C. G. McIlwraith and J. B. Breazeale, "Instrument applications of low friction magnetic bearings"; Eugene Mittelman, "Heat transfer measurements under dynamic conditions"; C. B. Moore, "A noncontacting static meter for textile yarn"; Henry J. Noebels, "New instrumentation for measuring substances in the ppm region"; Louis Rosenthal, "An automatic heating-cooling curve apparatus"; E. W. Silvertooth, "Tracking instrumentation for balloon-borne telescope"; Lloyd Slater, "The academic stature of instrumentation"; Harry Sohon, "A novel method of measuring electrical phase angles"; Frederick Vanderschmidt and J. C. Simons, Jr., "New instruments using radioisotopes as ionizing sources"; R. R. Webster, R. L. Uphoff, and J. F. Laycak, "An acoustic volume gage."

Elastomers

Edwin B. Newton, *chairman*
Paul G. Carpenter, *vice chairman*

4 Aug. W. Postelnik, "Status of the high temperature polymer program"; W. F. Watson, "Mechanico-chemical reactions of polymers"; G. S. Trick, "Effects of microstructure on crystallization rates of elastomers."

5 Aug. M. Berger, "Kinematics of a rolling tire and its application to tire performance"; D. C. Edwards and E. B. Storey, "The union of butyl rubber with carbon black"; A. M. Gessler, "Subnormal structure channel blacks and their reinforcing effect in rubber."

6 Aug. B. Ellis and G. N. Welding, "Vulcanization characteristics of natural rubber gum stock ACS-1"; C. J. Jankowski, R. F. Neu, and R. L. Zapp, "New vulcanization studies with butyl rubber"; David Craig, D. E. Diller, R. B. Fowler, F. A. Regenass, E. H. Rowe, W. L. Semon, J. J. Shipman, and H. Tucker, "Perdeuterio SN rubber."

7 Aug. Maurice Morton and Alan Rembaum, "Some aspects of homogeneous anionic polymerization"; Paul Fugassi, "The sorption of benzene by natural and synthetic polymeric hydrocarbons"; Melvin Mooney, "The rheology of visco-elastic materials."

8 Aug. Henno Keskkula, J. A. Schmidt, and J. G. Cobler, "Methods of studying rubber-polystyrene compositions."

Food and Nutrition

Robert H. Silber, *chairman*
Lester J. Teply, *vice chairman*

11 Aug. Aline U. Orten, "The intestinal absorption of amino acids"; Alfred E. Harper, "Amino acid balance and imbalance"; James M. Hundley, "Vegetable proteins in human nutrition"; Theodore Van Itallie, "Physiological aspects of hunger and satiety."

12 Aug. Roselyn Alfin-Slater, "Further observations in fatty acid nutrition"; Albert Behnke, "Changes in gross body composition and in adipose tissue as a result of caloric restriction"; F. N. Andrews, "Hormonal relationships to nutrition in domestic animals"; Franklin C. McLean, "Hormonal and nutritional factors in osteoporosis."

13 Aug. R. R. Williams, "Food supplementation in relation to world food shortage"; O. L. Kline, "Food supplementation"; Olaf Mickelson, "Is toxicology enough for a food protection program?"; Josef Warkany, "Nutritional experiments as an instrument of research in congenital malformations"; Josef Brozek, "Recent developments in studies of the relations between nutrition and behavior."

14 Aug. Mark Hegsted, "The establishment of nutritional requirements of man"; Calvin Woodruff, "Infant nutritional requirements—[illegible], fancy, and calculations"; Arnold Schaefer, "Nutritional surveys in the [illegible] and the Far East"; William J. Darby, "The program of nutrition of the World Health Organization."

15 Aug. S. H. Wittwer, "Effect of gibberellin on plant growth and composition"; Kenneth Beeson, "Effects of fertilizers on the nutritional value of plants."

Medicinal Chemistry

Maynard B. Chenoweth, *chairman*
Alfred Burger, *vice chairman*

18 Aug. Symposium on fundamentals in medicinal chemistry: Bernard Belleau, "Fundamental principles governing adrenergic blocking activity of beta-haloalkylamines"; E. J. Ariens, "Affinity and intrinsic activity in medicinal chemistry"; George B. Brown, "Some biologically active purine derivatives"; B. R. Baker, "Mechanisms of action of certain non-competitive inhibitors."

19 Aug. Symposium on fundamentals in pharmacology: Walter F. Riker, "An analysis of quaternary ammonium action at the neuromuscular synapse"; Edith Bülbring, "The function of 5-hydroxytryptamine in peristalsis"; Desmond R. H. Gourley, "Effects of drugs on active transport"; Aser Rothstein, "The cell surface as the site of action of drugs and metals."

20 Aug. Symposium on central nervous system stimulants: John H. Biel, "Chemistry of some central stimulants"; Leo G. Abood, "The psychotogenic action of piperidyl benzilates and related substances"; Lewis Danziger, "Some servo mechanisms in medicinal chemistry"; Mildred C. Rebstock, "Natural and synthetic antibiotic families."

21 Aug. Symposium on adrenal cortical inhibition and aldosterone: W. L. Bencze and M. J. Allen, "Chemistry of amphenone-analogs"; J. J. Chart and H. Sheppard, "Pharmacology of amphenone-analogs"; K. Heusler, O. Wieland, H. Ueberwasser, and A. Wettstein, "A new total synthesis of aldosterone"; Dickinson W. Richards, "Pharmacology of the lung: present knowledge and future needs."

22 Aug. Symposium on salicylates: Richard V. Heinzelman, "Chemistry of newer salicylates"; William B. Bass, "Pharmacology of newer salicylates"; Raymond W. Houde, "Analgesics related to salicylic acid: clinical studies in patients with pain due to cancer."

Cancer

H. G. Schlumberger, *chairman*
Frederik B. Bang, *vice chairman*

25 Aug. J. J. Biesele, "Early cytological effects of carcinogens"; Stanfield Rogers, "Mechanism of urethane-induced lung carcinoma in mice"; Wilhelm Hueper, "Carcinogenic studies on

water soluble and insoluble macromolecules"; C. Sommers, "Pathological evidence of endocrine imbalance in cancer patients"; J. Leighton, "Mechanisms of tumor invasion as seen in tissue culture."

26 Aug. L. Kilham, "Fibroma of squirrels transmitted by a virus immunologically related to the Shope rabbit fibroma virus"; R. C. Mellors, "Fluorescent antibody study of viruses in experimental neoplasms"; J. A. Reyniers, "Germ-free animals and cancer research." Alfred Gellhorn, *chairman*: Abraham Goldin, "Competitive analogue-metabolite relationships in cancer chemotherapy"; Julian J. Jaffé, "The chemotherapy of neoplasms using azauracil and azauridine"; J. F. Holland, "Tumor suppressive activity in tumor ascites fluid."

27 Aug. E. Zwilling, "Differentiation of early chick embryo tissues following disaggregation and reaggregation"; D. McKay, "Histochemistry of the migrating primordial germ cell"; G. Barry Pierce, "Tissue—and organogenesis in mouse teratomas"; H. S. Fleming, "Organoid growth of transplants in the eye"; W. F. Loomis, "The role of CO_2 tension in cell differentiation (*Hydra*)."

28 Aug. E. C. Hammond, "Epidemiological methods in cancer research"; Lalla Iverson, "Incidence of chorioepithelioma in Southeast Asia"; J. Higginson, "Cancer in the South African Bantu"; E. S. Wynne, "Epidemiology of 'cancer eye' in cattle"; H. Innes, "Divergent susceptibilities of animal species to different types of cancer."

29 Aug. Henry Plaine, *chairman*: A. E. Kehr, "Genetic tumors in plants (*Nicotiana*)"; Madge T. Macklin, "Heredity in human cancer"; F. Friedman and L. Burton, "Etiology of tumors in *Drosophila*."

New Hampton School

Physical Metallurgy

John Frye, Jr., *chairman*
Walter R. Hibbard, Jr., *vice chairman*

Microstructures: Their Origin and Influence on Properties

9–13 June. Special techniques: H. Wilsdorf, "Electron microscopy"; R. M. Fisher, "Electron probe analyzer"; R. Gomer, "Emission microscopy"; A. V. Baez, "X-ray microscopy." *Dislocations studies*: W. G. Johnston, "Etch pits"; S. A. Kulin, "X-ray techniques"; D. C. Robinson, "Electron microscopy"; A. R. Lang, "Berg-Barrett techniques." *Precipitation and 2nd phases*: J. Cahn, "Quantitative metallographic techniques"; Jack Washburn, "Precipitation on dislocations"; John Hilliard, "Kinetics of precipitate nucleation and growth"; A. J. Kelly, "Deformation of single crystals of age hardened aluminum alloy"; A. J. Cochart, "Role of second phases in creep." *Deformation and fracture*: J. R. Low and R. W. Guard, "Slip in iron alloys"; Morris Cohen, "Brittle behavior in steel"; Peter Gibbs, "Brittle fracture of crystals"; Jack Gilman, "Dislocations and fracture." *Oxidation and corrosion*: W. D. Forgeng and W. W. Webb, "Crystal growth during oxidation"; Ralph Condit, "Sulfurization of iron"; D. Van Rooyen, "Oxidation nucleation"; V. J. Albano, "Metallic films"; D. Vermilyea, "Oxidation kinetics."

Proteins and Nucleic Acids

Paul Zamecnik, *chairman*
Stanford Moore, *vice chairman*

16–20 June. Structural studies on nucleic acids. Unusual constituents of nucleic acids. The mechanism of synthesis of ribonucleic acid and of deoxyribonucleic acid. The relationship of ribonucleic acid to protein synthesis. Intermediate reactions in protein synthesis. The incorporation of analogues into nucleic acids and proteins. Speakers and discussants: G. Cohen, W. E. Cohn, F. Crick, B. Davis, P. Doty, A. Kornberg, C. Levinthal, F. Lipmann, R. Loftfield, M. Meselson, S. Moore, H. Neurath, S. Ochoa, V. Potter, J. Watson, and P. Zamecnik.

Coal

Alfred R. Powell, *chairman*
Henry C. Howard, *vice chairman*

23 June. Coal tar, W. M. Bywater, discussion leader: E. W. Volkmann, "The structure of coal tar"; R. W. Dornte, "Composition of high-temperature coke oven topped tar and creosote"; N. T. Shideler and F. Whittier, "Pitches and their modifications for special uses"; F. E. Cislak, "Pyridine bases—their characterization."

24 June. Martin B. Neuworth, "The composition of the low-temperature tar neutral oil"; H. R. Batchelder, "Battelle studies on lignite tar." *Coal hydrogenation,* E. E. Donath, discussion leader: F. J. Dent, "The hydrogenation of coal for gaseous hydrocarbons"; R. W. Hiteshue, "High-temperature coal hydrogenation."

25 June. H. R. Linden, "Coal pretreatment and hydrogenation to high-BTU gas"; M. D. Schlesinger, "Low-pressure coal hydrogenation." *Coal gasification,* L. L. Newman, discussion leader: Xavier Duval, "The reactions of carbon with water vapor"; C. G. von Fredersdorff, "Kinetics of fixed-bed and suspension systems of coal gasification."

26 June. W. H. Oppelt, "Considerations in the design of a liquid slag removal system for a pressurized fixed-bed generator"; F. J. Dent, "Experiments on the gasification of coal in fixed-bed pressure gasifiers"; Sabri Ergun, "Tracer techniques in the investigation of the nature of reaction sites"; C. D. Pears, "Process variables and parameters in the underground gasification of coal". *Paths in coal research,* Henry C. Howard, discussion leader.

27 June. H. H. Lowry, Martin B. Neuworth, Irving Wender.

Magnetic Resonance

H. S. Gutowsky, *chairman*
Clyde A. Hutchison, Jr., *vice chairman*

30 June. High resolution nuclear magnetic resonance, Harden M. McConnell, *chairman*: James N. Shoolery, "Interpretation of high resolution NMR spectra and current chemical applications"; H. J. Bernstein, "Methods of high resolution spectral analysis." H. S. Gutowsky, *chairman*: John R. Zimmerman, "Influence of intermolecular interactions on chemical shifts"; J. A. Pople, "The interpretation of proton chemical shifts"; S. Meiboom, "The study of chemical exchange kinetics by NMR."

1 July. Nuclear magnetic relaxation, N. Bloembergen, *chairman*: L. O. Morgan, "Proton spin relaxation by paramagnetic species"; C. A. Reilly, "Proton magnetic relaxation in some aromatic molecules"; D. W. McCall, "Diffusion and relaxation in simple liquids." *Paramagnetic resonance of free radicals,* Clyde A. Hutchison, Jr., *chairman*: George Fraenkel, "Topics in paramagnetic resonance of free radicals"; S. I. Weissman, "Electron exchange effects in electron spin resonance."

2 July. Irradiation-produced free radicals, H. S. Jarrett, *chairman*: Walter Gordy, to be announced; R. K. Waring, to be announced. *Theoretical aspects of magnetic resonance in molecular species,* B. P. Dailey, *chairman*: Martin Karplus, "Theoretical interpretation of electron coupled spin-spin interactions"; Harden M. McConnell, "Relation between magnetic resonance spectra and molecular electronic structure."

3 July. Magnetic resonance in solids, G. E. Pake, *chairman*: John Waugh, "Structure and ionic motions in complex salts"; R. G. Shulman, "NMR in magnetic solids." S. I. Weissman, *chairman*: H. S. Jarrett, "Ferrimagnetic resonance in $NiMnO_3$"; Clyde A. Hutchison, Jr., "Paramagnetic resonance of lanthanides and actinides."

4 July. Recent developments in high-resolution nuclear magnetic resonance instrumentation, E. G. Baker, *chairman*: W. A. Anderson and G. A. Williams, to be announced.

Organic Coatings

E. R. Mueller, *chairman*
D. F. Koenecke, *co-chairman*

7 July. Frederick R. Eirich, "Graft and block polymers"; John C. Cowan, "Vinyl ethers of unsaturated fatty alcohols: promising new protective coating vehicles."

8 July. Ray L. Heinrich and David A.

Berry, "Monocarboxylic aromatic acids in alkyd coatings"; J. K. Craver, "New epoxy resins in surface coatings"; D. W. Caird, "Solution and film forming properties of lexan polycarbonates."

9 July. Raymond R. Myers, "The rheology of film application by rollers"; James H. Taylor, "Application of hydrodynamic theory to the roll mill NIP."

10 July. Samuel Gusman, "A study of factors affecting the adhesion to metal of certain vinyl poylmers"; Elaine Shafrin, "Factors affecting wettability of organic surfaces."

11 July. H. Lacks, "Icephobic coatings."

Organic Reactions and Processes

Charles K. Bradsher, *chairman*
Robert I. Stirton, *vice chairman*

14 July. C. K. Bradsher, introductory remarks; C. D. Marshall, C. W. Smith, B. P. Geyer, G. W. Hearne, S. A. Ballard, H. DeV. Finch, and R. R. Whetstone, "Aerolein chemistry and derivatives"; B. C. McKusick, "Synthesis and chemistry of tetracyanoethylene."

15 July. Discussion on free radicals, Cheves Walling, discussion leader: Cheves Walling, introductory remarks; Frank R. Mayo, "Autoxidation of unsaturated compounds"; Bernhard Raecke, "The rearrangement of salts of aromatic and heterocyclic acids."

16 July. William D. Emmons, "The preparation, reactions, and synthetic applications of oxaziranes"; Nelson J. Leonard, "Amine oxidation"; H. C. Longuet-Higgins, "The molecular orbital theory of conjugated systems."

17 July. J. F. Bunnett, "Nucleophilic aromatic substitution"; P. O. Tawney, A. R. Williams, and R. H. Snyder, "The chemistry of maleimide, N-carbamylmaleimide and derived structures"; Benjamin Phillips, "The synthesis and reactions of aliphatic peracids."

18 July. N. B. Lorette, "The preparation and reactions of simple ketone acetals."

Statistics in Chemistry and Chemical Engineering

Frank Wilcoxon, *chairman*
Richard DeGray, *vice chairman*

21 July. R. Bradley, *chairman*: L. Moses, "Recent developments in ranking methods." M. Terry, *chairman*: W. Kruskal, "Population characteristics related to ranking methods."

22 July. O. L. Davies, *chairman*: D. Frazier, "The analysis of an inter-laboratory study"; J. Mandel, "Intra- and inter-laboratory testing—a general approach." G. E. Box, *chairman*: W. H. Glancy, "Experiences in the comparison of inter-laboratory data."

23 July. R. DeGray, *chairman*: C. M. Mottley, "The application of statistics in scientific investigation." E. Bianco, *chairman*: G. E. Ferris, "Subjective testing in industrial research."

24 July. B. Carpenter, *chairman*: A. Stein, "Uses and misuses of sampling inspection plans." S. M. Free, *chairman*: Harry Smith, Jr., "The simultaneous analyses of multiresponse designs."

25 July. Gertrude Cox, *chairman*: H. O. Hartley, "Application of balanced experimental designs in industry."

Steroids and Related Natural Products

Gilbert Stork, *chairman*
Elias J. Corey, *vice chairman*

28 July–1 Aug. D. H. R. Barton, "Some photochemical transformations in natural products chemistry"; C. Djerassi, to be announced; A. Bowers, to be announced; B. C. L. Weedon, "Some studies on natural polyenes"; A. Eschenmoser, to be announced; K. Wiesuer, "Recent progress in the chemistry of alkaloids"; E. P. Olivetto, "New chemistry of 11-oxygenated steroids"; L. H. Sarett, to be announced; R. B. Woodward, to be announced; W. S. Johnson, "Recent progress in the synthesis of steroids"; Oskar Jeger, to be announced; Josef Fried, to be announced.

Radiation Chemistry

William H. Hamill, *chairman*
Warren M. Garrison, *vice chairman*

4 Aug. H. C. Longuet-Higgins, "Structure and stability of ions"; J. L. Magee, "Charge transfer in gases."

5 Aug. H. M. Rosenstock, "Statistical theory of mass spectra"; Max Wolfsberg, "Theoretical study of mass spectra of alcohols"; D. P. Stevenson, "Survey of bimolecular processes in the mass spectrometer"; J. L. Franklin, "Ion-molecule reactions in the mass spectrometer."

6 Aug. T. H. Anderson, "Effects of irradiation of organic substances at 77°K"; W. Kanzig, "Structure of electron deficient color centers"; P. H. Yuster, "Effects of x-ray irradiation on alkali halide crystals containing impurity ions"; E. H. Taylor, "Effect of radiation on catalytic properties of solids."

7 Aug. M. Magat, "Effects of solutes in organic systems"; R. H. Schuler, "Radiation chemistry of organic systems"; C. D. Wagner, "Some aspects of radiolysis of *n*-paraffins"; R. Bell, "Common features of photo- and radiation-induced addition of chlorine to aromatics."

8 Aug. A. O. Allen, "Kinetics of water radiolysis under heavy particle irradiations"; (speaker to be announced), "Irradiation of aqueous systems."

Analytical Chemistry

Louis Gordon, *chairman*
John Mitchell, Jr., *vice chairman*

11 Aug. Charles N. Reilley, "Chelometric analysis"; Edward J. Griffith, "Thermogravimetry."

12 Aug. H. W. Kirby, "Progress report on radio chemistry in inorganic analysis"; G. Duyckaerts, "Infrared analysis of solids."

13 Aug. Harlan Foster, "Nuclear magnetic resonance"; open discussion.

14 Aug. W. Klyne, "Optical rotatory dispersion"; E. W. Abrahamson, "Analysis of reaction intermediates."

15 Aug. J. B. Neilands, "Enzymatic reactions."

Inorganic Chemistry

H. B. Jonassen, *chairman*
R. W. Mason, *vice chairman*

18–19 Aug. Organometallic complexes of the transition metals, Heinz Sternberg, *chairman*: J. Chatt, "Metal olefin complexes"; G. Ecke, "Recent developments in organomanganese chemistry"; R. P. Eischens, "Infrared spectra of chemisorbed species containing metal-carbon bonds"; H. H. Jaffe, "Nature of the metal-carbon bond"; R. S. Nyholm, "Substituted metal carbonyls"; P. L. Pauson, "Organometallic complexes of the transition metals"; R. E. Rundle, "Structure of organometallic complexes"; M. C. Whiting, "Structure and catalytic properties of some metal carbonyl complexes."

20 Aug. Nonaqueous solvents, Leonard Katzin, *chairman*: Dieter M. Gruen, "Molten salt solutions"; George Watson, "Molten fluorides as high-temperature solvents"; Max T. Rogers, "Interhalogen systems"; Alan F. Clifford, "HF solutions"; C. C. Addison, "Nitrogen oxide systems"; S. Bruckenstein, "Acetic acid systems."

21–22 Aug. Inorganic polymers, Charles Haber, *chairman*: L. F. Audrieth, "Inorganic polymerization reactions"; W. Conard Fernelius, "Semi-inorganic coordination polymers"; (speaker to be announced), "Theoretical consideration in search for inorganic polymer systems."

Chemistry of Adhesion

G. W. Koehn, *chairman*
Alan A. Marra, *vice chairman*

25–29 Aug. H. P. Brown and J. F. Anderson, "Adhesive properties of carboxylic rubbers"; K. R. Williams and H. T. Patterson, "Adhesion of fibers to elastomers"; J. S. Long, "Hydrophyl balance measurements"; B. W. King, "Adhesion of porcelain enamels to metal." *High temperature adhesives:* D. G. Bennett, "Ceramic adhesives"; H. H. Levine, "Triazine compounds"; F. H. Bair, "Other high performance adhesives"; C. A. Dahlquist, "Tack"; Turner Alfrey, "Role of cohesive failure in adhesive bonds"; C. E. Schildknecht, "Advances in graft polymerization"; D. S. Ballantine and D. J. Metz, "Graft polymerization by irradiation"; H. A. Smith, "Preparation and properties of monolayers on active metal surfaces."

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Lipide Metabolism

Warren M. Sperry, *chairman*

Donald B. Zilversmit, *vice chairman*

9 June. Analytical methods, Donald B. Zilversmit, *chairman*: Hermann Schlenk, "Paper chromatography of lipides"; S. R. Lipsky, "The application of gas liquid chromatographic techniques to the analysis of lipide mixtures." *Analytical methods and complex lipides,* William Insull, *chairman*: Norman K. Freeman, "Infrared spectroscopy in lipide analysis"; Herbert Meltzer, "Separation of complex lipides by three phase countercurrent fractionation."

10 June. Analytical methods and sphingolipides, Martin Marcus, *chairman*: Norman Radin, "Sphingolipide metabolism and chromatography"; Maurice M. Rapport, "A serological expedition to the field of sphingolipides"; Samuel Bogoch, "Neuraminic acid in brain ganglioside and in cerebrospinal fluid." *Sphingolipides,* David M. Tennent, *chairman*: J. Folch-Pi, "Study of the brain ganglioside-strandin"; E. Klenk, "Mucoproteins and mucolipides of erythrocytes."

11 June. Sphingolipides, Michael C. Schutz, *chairman*: Eli Robins, "Biochemical changes in developing white matter"; Benjamin Weiss, "Synthesis of sphingosine derivatives"; Roy Gigg and Herbert E. Carter, "The chemistry of sphingolipides." *Biosynthesis of sphingolipides,* Leon Swell, *chairman*: Jonathan B. Wittenberg, "Sphingosine biogenesis"; Roscoe O. Brady, "The enzymatic synthesis of glycosphingolipides."

12 June. Biosynthesis of sphingolipides, sterols, and fatty acids, H. C. Meng, *chairman*: Irving Zabin, "Biosynthesis of sphingolipides"; George Alexander and Erwin Schwenk, "New experiments on the biosynthesis of sterols"; Marvin D. Siperstein, "The nature of the lipogenic defect in diabetes." *Biosynthesis of fatty acids,* Clyde T. Caldwell, *chairman*: D. E. Green, D. M. Gibson, S. J. Wakil, and E. Titchener, "The reconstruction of the fatty acid synthesis system of pigeon liver"; F. Lynen, "Biosynthesis of fatty acids by purified enzymes."

13 June. Biosynthesis of phosphatides and triglycerides, Alex Lesuk, *chairman*: K. P. Strickland and R. J. Rossiter, "Biogenesis of phosphatides and triglycerides"; E. P. Kennedy, "The enzymatic synthesis of complex lipides."

Cell Structure and Metabolism

Montrose J. Moses, *chairman*

The Muscle Cell

16 June. Definitive aspects: H. Ruska and C. A. Edwards, "Comparative structure and organization of the muscle cell"; S. V. Perry, "Chemical organization of muscle cells"; D. Wilkie, "Physiological parameters of muscle cell function"; A. Sandow, discussion leader.

17 June. Membrane limited structures of the muscle cell: G. Palade, "Fine structure of the sarcosomes"; E. G. Slater, "Biochemistry of the sarcosomes"; K. R. Porter, "The sarcoplasmic reticulum."

18 June. Contraction: A. Huxley, "Light microscopic observations on contracting muscle"; S. Inoué, "Polarized light studies of muscle contraction"; A. J. Hodge, "Changes in fine structure associated with contraction. A review of recent concepts"; A. G. Szent-Gyorgyi, discussion leader. J. Gergely, "Myosin and actomyosin: reality or artifact?"; H. Holtzer and J. Marshall, "Localization of muscle proteins."

19 June. Contraction: T. Hayashi, "Model contraction systems"; W. F. H. M. Mommaerts, "Energy supplying systems and contraction"; A. Csapo, "Possible link between intact muscle and models"; discussion; L. Lorand, "Relaxing factors."

20 June. Neuromuscular relationships: R. Couteaux, "Cytochemistry and morphology of the subneuronal apparatus"; J. del Castillo, "Physiological function of the motor end plates"; R. J. Barrnett, discussion.

Nuclear Chemistry

John R. Huizenga, *chairman*

Morris L. Perlman, *vice chairman*

23–27 June. Nuclear spectroscopy, application of the shell and unified nuclear models in the interpretation of experimental results. Coulomb excitation. Photonuclear reactions, dependence of the cross section for formation of an excited nucleus by gamma-ray absorption on nuclear deformation. Heavy ion reactions. Discussion of Γ_n *and* Γ_f *as function of energy, atomic weight, and number. Hot atom chemistry. Chemical techniques. Geochemistry including cosmic abundances and synthesis of the elements.* Speakers and detailed program to be announced.

Solid State Studies in Ceramics

M. L. Kronberg, *chairman*

William D. Kingery, *vice chairman*

High Temperature and High Pressure Phenomena

30 June–4 July. P. W. Gilles, "Vapor species above solids—particularly oxides"; A. J. Thorn, discussion. R. E. Carter, "Determination of dissociation pressures of oxides by use of galvanic cells"; S. L. Blum, discussion. A. Muan, "Equilibria among gas, liquid and crystalline phases in oxide systems involving changes in oxidation states"; T. B. King, "Water solubility and oxygen diffusion in molten silicates." C. E. Birchenall, J. E. Burke and G. C. Kuczynski, in a comprehensive discussion of "The current status and trends in the fields of diffusion and sintering." R. Roy, "Crystal chemical observations on high pressure phase relationships"; G. C. Kennedy, discussion. H. T. Hall, "Some recent developments in high pressure chemistry"; S. Zerfoss, discussion. R. Chang, "Creep of ceramic oxides at high temperatures and low stresses"; J. A. Pask, discussion. D. T. Griggs, "Some mechanical properties of minerals at high temperatures and high stresses"; M. L. Kronberg, discussion. S. P. Mitoff, "Electrical conductivity of single crystals of magnesium oxide at elevated temperatures." W. B. Crandall, "Unsteady-state heat transfer at elevated temperatures"; W. D. Kingery, discussion. R. B. Sosman, guest lecture, "A scientific-technologic survey of eating places." A number of scientists from abroad will attend and will report on current research in their respective institutions. They are: H. J. Oel, J. White, E. W. Gorter, A. L. Roberts, K. Hauffe, P. Murray or D. Livey, R. Lindner, and K. Torkar.

Chemistry and Physics of Isotopes

Russell Baldock, *chairman*

Ralph Weston, *vice chairman*

7–11 July. Natural abundance of isotopes (geological and biological significance). Theoretical aspects of kinetic isotope effects. Applications of kinetic isotope effects to reaction mechanisms. Solvent properties of heavy water. Isotope separation (emphasis on chemical exchange). Isotopes in geology. Some new applications in mass spectrometry. Brief progress reports on current research activities.

Chemistry, Physiology and Structure of Bones and Teeth

D. Dziewiatkowski, *chairman*

Wallace D. Armstrong, *vice chairman*

14 July. Elaboration of the inorganic structures in bones and teeth, Reidar F. Sognnaes, *chairman*: J. T. Albright and R. F. Sognnaes, "Fine structure of the inorganic elements in adult bones and teeth"; S. F. Jackson, "Structural relationship between inorganic and organic elements in embryonic bone." Baird Hastings, *chairman*: Honor B. Fell, "The study of skeletal physiology by the organ culture method."

15 July. Physics of the solid state, John H. Marshall, *chairman*: N. H. Nachtrieb, "Dynamics of the solid state"; W. F. Neuman, "The bone crystal"; A. S. Posner, discussion. Karl Meyer, *chairman*: Harry Bostrom, "Aspects of the metabolism of mucopolysaccharides."

16 July. Enzymes of bone, Alexander B. Gutman, *chairman*: P. Robbins and F. D'Abramo, "Active sulfate and the

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AET Hydrobromide (2-amino-ethyl isothiouronium)	Antiradiation
Beta-Naphthyl Acetate, and 6-Bromo-2-Naphthyl acetate	Acetyl choline esterase
Sodium-6-Benzoyl-2-naphthyl phosphate	Phosphatase
2-(4-Hydroxybenzeneazo) benzoic acid	Albumin in blood plasma
Carbonaphthoxy choline iodide	Serum choline esterase
6-Bromo-2-naphthyl-beta-D-glucuronide	Beta-glucuronidase
Indoxyl acetate	Esterase and acetyl choline esterase
N-Benzoyl-dl-phenylalanine beta naphthol ester	Chymotrypsin
L-Leucyl-beta-naphthylamide hydrochloride	Leucine amino peptidase
Reinecke Salt	Choline
Thioacetamide	Precipitant for metal ions
Neutral Buffered formaldehyde solution	Fixation
5-Nitrobenzotriazole	Nitroreductase
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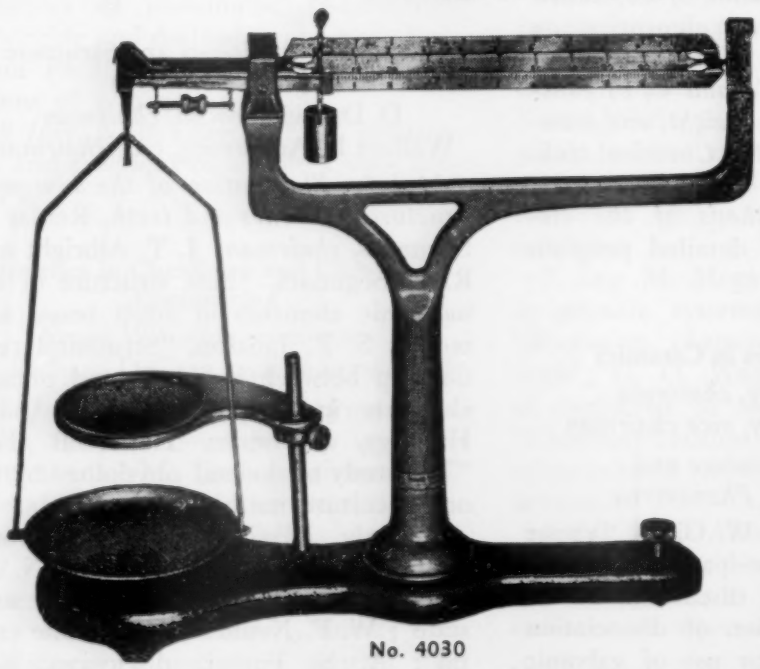

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synthesis of chondroitin sulfate"; H. F. DeLuca, "Vitamin D and citrate metabolism." Franklin C. McLean, *chairman*: Nicolas Eeg-Larsen, "Glycolysis in epiphyseal cartilage."

17 July. Chemistry and physiology of the parathyroid hormone, John E. Howard, *chairman*: H. Rasmussen, "Studies on the isolation of the parathyroid hormone"; C. Rich, M. Horwith, D. Thompson, and H. Rasmussen, "Physiological effects of purified parathyroid hormone in humans." E. C. Reifenstein, Jr., *chairman*: E. Kodicek, "Metabolism of vitamin D."

18 July. Current research trends, Wallace D. Armstrong, *chairman*: contributed short papers, to be selected.

Chemistry at Interfaces

Stephen Brunauer, *chairman*
Norman Hackerman, *vice chairman*

21 July. Chemical reactions at interfaces, Herman E. Ries, Jr., *chairman*: E. A. Gulbransen, "Structural aspects of reactions at solid-gas interfaces"; Alexandre Rothen, "Studies of enzymatic reactions at a solid-liquid interface"; J. H. Schulman, "Selective interaction of sodium and potassium ions with surface active agents at solid-liquid and liquid-liquid interfaces."

22 July. Electrical phenomena at interfaces, H. van Olphen, *chairman*: Pasupati Mukerjee, "Some interactions of amphipathic ions in aqueous solutions"; D. T. Rogers, "Tribo-electric properties of distillate fuels"; David C. Grahame, "Factors affecting the adsorption of ions at interfaces."

23 July. Adsorption, L. E. Copeland, *chairman*: A. C. Zettlemoyer, "Chemisorption on metals"; Fred Karush, "Adsorption of small molecules by proteins"; G. M. Schwab, "Chemisorption and catalysis."

24 July. Interfaces in dispersed systems, A. J. G. Allan, *chairman*: R. K. Iler, "Recent developments in the surface chemistry of silica and silicates"; C. R. Singleterry, "Detergents in organic media"; R. D. Vold, "Packing and ionization of layers of sodium dodecyl sulphate adsorbed on carbon particles"; A. M. Gaudin, "Induced hydrophobicity in minerals."

25 July. General discussion.

High-Pressure Research

J. M. Lupton, *chairman*

28 July. High-pressure synthesis, C. M. Sliepcevich, *chairman*: H. Tracy Hall, "High-pressure, high-temperature developments"; C. Walling, "Organic reactions at high pressures." *Transport properties,* A. Michels, *chairman*: John Ross, "Transport processes in dense gases"; R. B. Dow, "Rheological properties at high pressures."

29 July. Measurement, correlation, and utilization of pressure, volume, and temperature data, W. C. Edmister, *chairman*: V. J. Berry, "Effects of pressure, temperature, and composition on the behavior of a gas condensate system"; A. Bondi, "A corresponding-states correlation without critical constants—application to the PVT properties of higher molecular weight hydrocarbons"; L. N. Canjar, "Treatment and correlation of light hydrocarbon PVT data"; J. B. Opfell, "Some limitations on applications of equations of states."

30 July. Solid state, H. G. Drickamer, *chairman*: H. Brooks, "Review of recent work on the effects of pressure on semiconductors"; W. B. Daniels and Charles S. Smith, "Single-crystal elastic constants to 10,000 atmospheres." *Optical properties,* A. W. Lawson, *chairman*: H. G. Drickamer, "Optical studies on the structure of solids"; B. Vodar, "Recent results on atomic and molecular spectra of compressed gases."

31 July. Geophysics, G. A. MacDonald, *chairman*: A. F. Birch, "Application of high-pressure research to problems in geophysics." *Molecular physics,* J. M. Lupton, *chairman*: A. Michels, "Some conclusions on interactions from recent high-pressure experiments."

1 Aug. Geochemistry, J. R. Gold-

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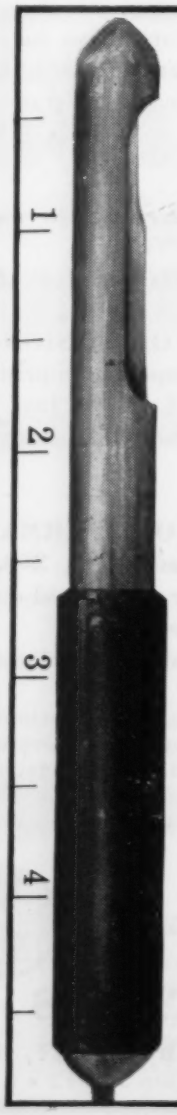

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smith, *chairman*: G. C. Kennedy, Rustum Roy, "Application of high-pressure research to problems in geochemistry."

Toxicology and Safety Evaluations

John A. Zapp, Jr., *chairman*
Don D. Irish, *vice chairman*

4 Aug. The laboratory animal in toxicity studies, Margaret Ives, *chairman*: L. Royal Christensen, "The endemic disease pattern in experimental animals"; C. N. Wentworth Cumming, "The care and nurture of laboratory animals." *The laboratory animal in toxicity studies,* O. G. Fitzhugh, *chairman*: Lloyd W. Hazleton and Bernard L. Oser, "The choice of animals as related to the interpretation of toxicity studies."

5 Aug. Statistical methods in toxicology, Carrol S. Weil, *chairman*: Jerome Cornfield, "Biometric approach to the planning and analysis of toxicity studies." *Estimation of hazards for man,* David W. Fassett, *chairman*: Hardin B. Jones, "Extension of laboratory and other data to populations."

6 Aug. Health hazards of nuclear reactors, Norton Nelson, *chairman*: Charles R. Williams, "The public heath aspect of nuclear reactors." *Metabolic and biochemical investigations in toxicity evaluations,* Arnold J. Lehman, *chairman*: F. A. Denz, to be announced.

7 Aug. Air pollution toxicology, Eugene R. Krackow, *chairman*: Herbert E. Stokinger, "Experimental evaluation of the toxicity of air pollutants"; Geoffrey Carey, "Clinical approach to the toxicity of air pollutants." *The role of judgment in toxicological research,* Don D. Irish, *chairman*: Maurice H. Seevers, "Horse sense in collecting and interpreting toxicological data."

8 Aug. Training of toxicologists, a panel discussion; Henry F. Smyth, Jr.; *chairman*: Henry F. Smyth, Jr., "The work and responsibilities of a toxicologist"; Elliott A. Maynard, "Past and current training of toxicologists"; E. M. K. Geiling, "Appropriate future training of toxicologists."

Chemistry and Physics of Metals

J. A. Krumhansl, *chairman*
E. I. Salkovitz and J. W. [illegible]
vice chairmen

11 Aug. Electronic structure—general: J. C. Slater, "Electron energy bands in metals"; A. F. Kip, "Cyclotron resonance"; D. H. Tomboulian, "Soft x-ray valence band emission studies."

12 Aug. Specific band determinations: G. Lehman, "Band structure of uranium and thorium"; J. R. Reitz, "Band structure of selenium and tellurium"; J. W. McClure, "Band structure of graphite." *Liquid metals*: S. Strauss, "Size effects in liquid alloys."

13 Aug. Transport properties: E. I. Salkovitz, "Transport properties in dilute alloys"; T. G. Berlincourt, "Hall

effect in metals and alloys"; A. I. Schindler, "Field dependent properties in transition metal alloys." *Elastic properties of metals and alloys*: J. R. Reitz, "Elastic constants of metals and alloys and electronic structure."

14 Aug. Point defects and electronic properties: F. J. Rowland, "Nuclear magnetic resonance in copper and silver alloys"; W. Harrison, "Influence of lattice disturbances on point defect scattering"; L. Roth, "Scattering of Bloch waves"; F. J. Blatt, "Thermoelectric power of noble metal alloys."

15 Aug. Special topics: L. Apker, "Recent progress in photoelectric emission"; H. Brooks, recapitulation.

Infrared Spectroscopy

F. A. Miller, *chairman*
V. Z. Williams, *vice chairman*

18 Aug. Spectra of trapped species, B. Crawford, Jr., *chairman*: J. A. A. Ketelaar, "Infrared spectra of crystalline solid solutions"; G. C. Pimentel, "Matrix methods." *Infrared spectra of adsorbed molecules*: A. Terenin, "Infrared spectra of molecules adsorbed on solid surfaces"; William A. Pliskin and R. P. Eischens, "The infrared spectra of carboxylic acids chemisorbed on metals and metal oxides."

19 Aug. Measurement of vibrational relaxation times, G. C. Pimentel, *chairman*: K. E. Shuler, "Theoretical aspects"; S. H. Bauer, "Experimental aspects." *Detectors for the infrared region*: E. F. Daly, "Infrared detectors."

20 Aug. Infrared intensities, D. A. Ramsay, *chairman*: D. F. Eggers, Jr., "Infrared intensities from band area measurements"; J. H. Jaffe, "Infrared intensities from dispersion measurements." *Raman intensities*: M. V. Volkenstein, "Theoretical aspects"; L. A. Woodward, "Experimental aspects."

21 Aug. The origin of group frequency shifts, V. Z. Williams, *chairman*: D. H. Whiffen, "Physical effects"; L. J. Bellamy, "Chemical effects." *Group intensities*: R. N. Jones, "Infrared intensities in liquid and solution phases."

22 Aug. F. A. Miller, *chairman*: L. J. Bellamy, B. Crawford, Jr., J. A. A. Ketelaar, R. C. Lord, H. W. Thompson, and N. Wright, "Infrared: its present needs and future directions," panel discussion.

Glass

James E. Archer, *chairman*
R. J. Charles, *vice chairman*

Physicochemical Aspects of Glass

25 Aug. General introduction: R. W. Douglas, "Transport phenomena in glasses"; (speaker to be announced), "Thermodynamic considerations of glasses and slags."

26 Aug. J. Uys, "Water in silicate melts"; panel presentation, "Room temperature reactivity of glasses."

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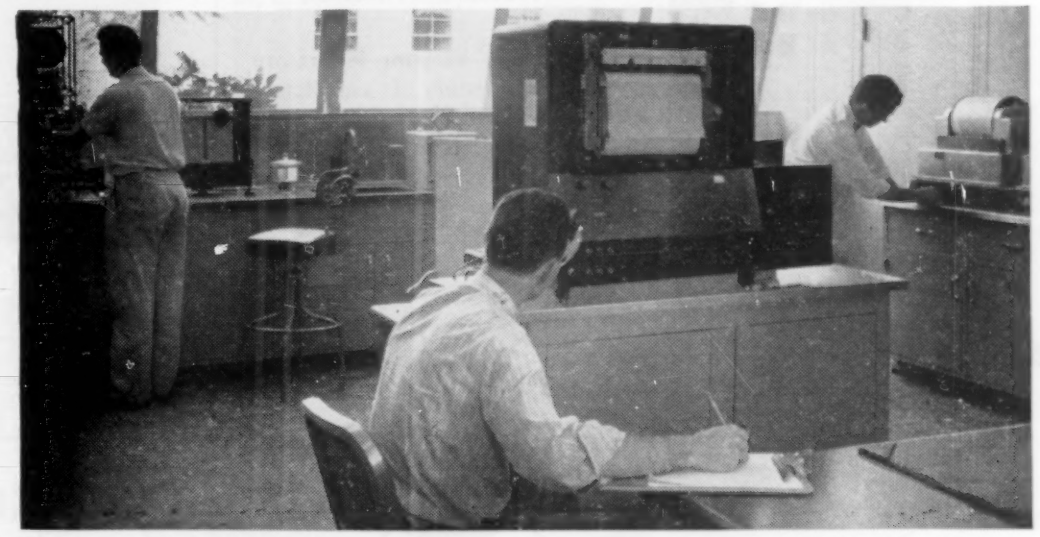

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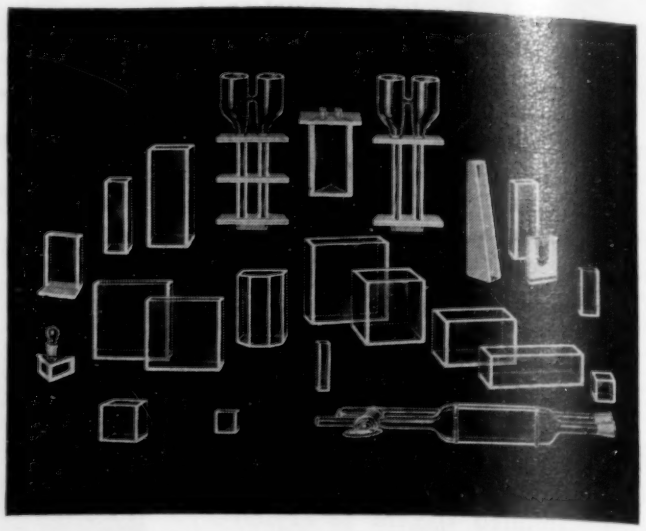

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27 Aug. J. Gibbs, "Nature of the glass transition in linear polymers"; W. Hillig, "Kinetic stability of the glassy state."

28 Aug. S. W. Barber, "Dispersion of acoustic waves at low temperature in binary alkali silica glass and its relation to other mechanical properties"; R. J. Charles, "Effect of temperature and atmosphere on the corrosion fatigue of lime glass."

29 Aug. Summary discussion; overflow papers; business meeting.

W. George Parks

Department of Chemistry, University of Rhode Island, Kingston

Society Elections

■ The Radiological Society: pres. and AAAS Council representative, Leo G. Rigler, Cedars of Lebanon Hospital, Los Angeles, Calif.; pres.-elect, Laurence L. Robbins, Massachusetts General Hospital, Boston; historian, Howard P. Doub, Henry Ford Hospital, Detroit, Mich.; sec.-treas., Donald S. Childs, 713 E. Genesee Street, Syracuse, N.Y. The vice-presidents are Robert D. Moreton, Fort Worth, Tex., James W. J. Carpenter, Chicago, Ill., and Everett L. Pirkey, Louisville, Ky.

■ Institute of Mathematical Statistics: pres., L. J. Savage, Eckhart Hall, University of Chicago; pres.-elect., Jacob Wolfowitz, Department of Mathematics, Cornell University (after late May 1958); sec., George E. Nicholson, Jr., Department of Statistics, University of North Carolina, Chapel Hill, N.C.; treas., A. H. Bowker, Department of Statistics, Sequoia Hall, Stanford, Calif. The representative to the AAAS is Harold Hotelling, Institute of Statistics, University of North Carolina.

■ American Academy for Cerebral Palsy: pres., William T. Green; pres.-elect, Robert A. Knight; treas., Samuel B. Thompson; sec., Raymond R. Rembolt, University Hospital, Iowa City, Iowa.

■ Optical Society of America: pres., Irvine C. Gardner; pres.-elect, John Strong; junior past pres., Ralph A. Sawyer; v. pres. for meetings, Stanley S. Ballard; sec., Kasson S. Gibson, National Bureau of Standards, Washington 25, D.C.; treas., E. D. McAlister; sec. for local sections, W. Lewis Hyde. The representative to the AAAS Council is C. C. Kiess, National Bureau of Standards, Washington, D.C.

■ American Mathematical Society: pres., Richard Brauer, Department of Mathematics, Harvard University; pres.-elect, E. J. McShane, University of Virginia; sec., John W. Green, Department of Mathematics, University of California, Los Angeles 24, Calif.; treas., Albert L. Meder, Jr., New York, N.Y. The vice presidents are Garrett Birkhoff, Harvard University, and Salomon Bochner and N. E. Steenrod, Princeton University. The representative to the AAAS Council is W. L. Duren, University of Virginia.

Forthcoming Events

March

31–2. Utilization of Atomic Energy, College Station, Tex. (R. E. Wainerdi, A.&M. College of Texas, College Station, Tex.)

April

1. Microcirculatory Conf., 5th, Buffalo, N.Y. (S. R. M. Reynolds, Dept. of Anatomy, Univ. of Illinois College of Medicine, 1853 W. Polk St., Chicago 12.)

1–2. Alabama Acad. of Science, annual, Birmingham. (H. M. Kaylor, Dept. of Physics, Birmingham-Southern College, Birmingham.)

1–2. Freezing and Drying Symp., 2nd Internatl., London, England. (L. G. Beckett, Institute of Biology, 41 Queen's Gate, London, S.W.7.)

1–3. Corrosion Control, 5th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

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2–4. American Assoc. of Anatomists, annual, Buffalo, N.Y. (L. B. Flexner, Dept. of Anatomy, School of Medicine, Univ. of Pennsylvania, Philadelphia 4.)

2–4. Instruments and Regulators Conf., Newark, Del. (W. E. Vannah, Control Engineering, 330 W. 42 St., New York 36.)

3–5. Pennsylvania Acad. of Science, annual, Easton, Pa. (G. R. Stevens, Dept. of Geology and Geography, Lafayette College, Easton.)

4–5. Southern Soc. for Philosophy and Psychology, annual, Nashville, Tenn. (W. B. Webb, U.S. Naval School of Aviation Medicine, Pensacola, Fla.)

7–11. American Assoc. of Cereal Chemists, annual, Cincinnati, Ohio. (J. W. Pence, Western Utilization Research Laboratories, Albany, Calif.)

8–10. Electronic Waveguides Symp., New York. (J. Fox, Microwave Research Inst., Polytechnic Inst. of Brooklyn, 55 Johnson St., Brooklyn 1, N.Y.)

9–12. National Council of Teachers of Mathematics, Cleveland, Ohio. (M. H. Ahrendt, NCTM, 1201 16 St., NW, Washington 6.)

9–14. Applied Psychology, 13th internatl. cong., Rome, Italy. (L. Meschieri, National Inst. of Psychology, Rome.)

10–11. American Inst. of Chemists, annual, Los Angeles, Calif. (L. Van Doren, AIC, 60 E. 42 St., New York 17.)

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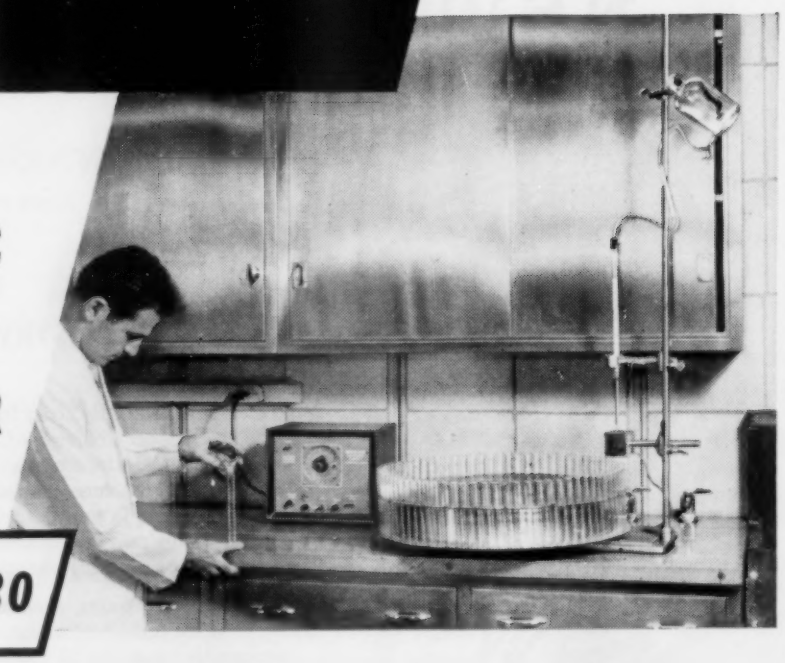

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10–12. Biometric Soc., ENAR, Gatlinburg, Tenn. (T. W. Horner, General Mills, Inc., 400 Second Ave. South, Minneapolis 1, Minn.)

10–12. National Speleological Soc., annual, Gatlinburg, Tenn. (G. W. Moore, Geology Dept., Yale Univ., New Haven, Conn.)

10–12. Ohio Acad. of Science, annual, Akron, Ohio. (G. W. Burns, Dept. of Botany, Ohio Wesleyan Univ., Delaware.)

11. Vitamin B-12 Symp., New York, N.Y. (Miss J. Watson, 451 Clarkson Ave., Brooklyn 3, N.Y.)

11–12. Eastern Psychological Assoc., annual, Philadelphia, Pa. (G. Lane, Dept. of Psychology, University of Delaware, Newark.)

11–12. Montana Acad. of Sciences, annual, Missoula. (L. H. Harvey, Montana State Univ., Missoula.)

11–18. Horticultural Conf., 15th internatl., Nice, France. (Secretariat General, 84, rue de Grenelle, Paris 7e, France.)

12. Society for the Scientific Study of Religion, New York. (L. Whitman, 297 Fourth Ave., New York, N.Y.)

13–14. American Soc. for Artificial Internal Organs, Philadelphia, Pa. (G. Schreiner, Georgetown Univ. Hospital, Washington 7.)

13–18. American Chemical Soc., 133rd, San Francisco, Calif. (R. M. Warren, ACS, 1155 16 St., NW, Washington 6.)

13–19. Federation of American Societies for Experimental Biology, annual, Philadelphia, Pa. (M. O. Lee, FASEB, 9650 Wisconsin Ave., Bethesda 14, Md.)

14–16. Automatic Techniques Conf., Detroit, Mich. (J. E. Eiselein, RCA, Bldg. 10–7, Camden 2, N.J.)

14–18. American Assoc. of Immunologists, annual, Philadelphia, Pa. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh 13, Pa.)

14–18. American Soc. for Experimental Biology, annual, Philadelphia, Pa. (J. F. A. McManus, Univ. of Alabama Medical Center, Birmingham.)

14–18. American Soc. of Biological Chemists, annual, Philadelphia, Pa. (P. Handler, Dept. of Biochemistry, Duke University School of Medicine, Durham, N.C.)

15–17. Gas Measurement, 34th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

16–25. Instruments, Electronics and Automation Conf., London, England. (Industrial Exhibitions Ltd., 9 Argyll St., London, W.1.)

17–18. Environmental Engineers, 2nd annual institute, New York. (Institute of Environmental Engineers, 9 Spring St., Princeton, N.J.)

17–18. Midwest Benthological Soc., annual, Madison, Wis. (K. M. Mackenthun, 453 State Office Bldg., Madison 2.)

17–19. Association of Southeastern Biologists, annual, Tallahassee, Fla. (J. C. Dickinson, Jr., Dept. of Biology, Univ. of Florida, Gainesville.)

17–19. Eastern Colleges Science Conf., 12th annual, Wilkes-Barre, Pa. (Mrs. E. Stevens, Wilkes College, Wilkes-Barre.)

(See issue of 21 February for comprehensive list)

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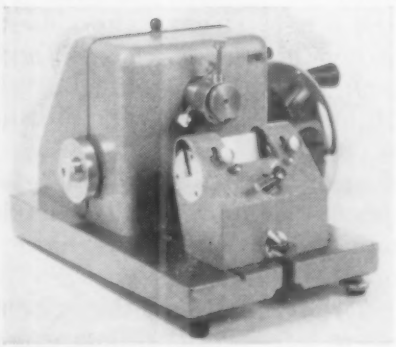

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LETTERS

The editors take no responsibility for the content of the letters published in this section. Anonymous letters will not be considered. Letters intended for publication should be typewritten double-spaced and submitted in duplicate. A letter writer should indicate clearly whether or not his letter is submitted for publication. For additional information, see Science **124**, *249 (1956) and* **125**, *16 (4 Jan. 1957).*

Auxiliary Languages

I was much interested in the issue of 12 July 1957, which editorially blessed the auxiliary language Interlingua [W. Davis, "Babel Resolved," *Science* **126**, 55 (1957)] and displayed it in the *tremendemente* readable article by F. F. Cleveland, "Communication in le Scientia" (page 64).

The article contains a number of words on which I should like to comment in the light of the claims made for Interlingua in the editorial, which boil down to the notion that it "can be read at sight by all who can read any Western European language."

Column 1, lines 11 and 12: Who besides Cleveland, the International Auxiliary Language Association, and the divinely inspired is going to understand *placiamento*? Even the faintly suggested English *placement* would be incongruous here.

Column 1, line 18: Jornales, here evidently used in the sense of "magazines," would be taken to mean "diaries" or "newspapers" by speakers of Romance languages. Semantic slippage of this sort is a common feature of Interlingua.

Column 1, line 22: Valorabile, apparently intended to mean "valuable," seems to be floating etymologically on nothing more solid than air, unless it be the rare Spanish *valorable*. It is not in the *Interlingua-English Dictionary*; this fact does not condemn the word, but it suggests that the composer in Interlingua may have his moments of mental torture.

Column 1 line 24: In what West European language does *tunc* occur, or anything remotely resembling it? Here is one thing, at least, that needs to be "studied and learned." It is immaterial whether or not one drags in the fact that it is taken from Latin.

Column 2, line 1: Where does the word *amonta* come from? Can it be English *amount,* pseudo-Romancified and tossed in the basket with the Latin first-declension feminines?

Column 2, line 7: The expression *facilitate de lectura* might well be interpreted by some over-relaxed English speaker as meaning "facility in lecturing" instead of "facility in reading."

Column 2, line 8: The idiom *in addition a* is completely foreign to the Romance languages. Unless Cleveland footnotes his Anglicisms, his Latin readers will have some things to study and learn.

Column 2, lines 11 and 12: In the expression *pro passar le examination,* two things call for comment. First, what is this dreadful word *examination* which is found in no language except English and is not listed in the *Interlingua-English Dictionary*? If a distinguished scientist who has been editing an Interlingua magazine since 1952 can still be the victim of such English mirages over his Interlingua landscape, what chance have the rest of us? Secondly, the word *passar* is semantically shaky here: does the phrase mean "*pass* an examination" like the equivalent English and Italian expressions (compare the Italian *passar ad un esame*), or does it merely mean "*take* an examination," like the French *passer un examen?*

Column 2, lines 34 and 35: The glib doctrine that Interlingua reads and writes itself has here tripped the writer over the word *singule*. His expression *in un singule lingua international* is evidently intended to mean "in a single [that is, one only] international language." The trouble is that neither the Latin *singulus* nor its derivative in any Romance language means "single" in the sense we are dealing with here.

Column 2, line 35: Cleveland has misspelled the word *preferabilemente*. The *Interlingua-English Dictionary* gives *preferibilemente,* which is required by the Interlingua principles of etymology. Was the text form a slip of the pen, or could the English *preferable* have beguiled the devotee of this painless auxiliary language?

Column 3, line 5: Where does the verb *maestrar* ("to master"?) come from? The closest thing on the Continent is French *maîtriser,* which is differently formed. Again, English dressed up in Romance feathers.

Column 3, line 10: When Cleveland writes *si multo* instead of *tanto,* his Latin colleagues have had it. But who can blame him? Interlinguists believe their language can be read without difficulty; they never claimed it could be read without exasperation.

Column 3, line 18: Ingagiate, according to the Interlingua dictionary, means "engaged" only in the sense of "employed, hired." Perhaps I mistake the writer's meaning, but I assume it is "occupied, busy." If so, another case of creeping Anglicism—none of the Continental cognates of *engage* has this meaning.

Column 3, line 22: Who will know *parve* ("small") except the Spaniard and the Latin scholar? (The Esperantist, by the way, doesn't have to know it.)

Column 3, line 27: Recipientes in the sense of English "recipients" will hardly do. The Interlingua dictionary, faithfully reflecting the usage of French, Italian, Spanish, and Portuguese, gives *recipiente* as a chemical term for a container and provides the distinct term *receptor* to represent the concept of a person receiving something.

It is hard to see how the writer in Interlingua can possibly keep faith with the spirit or the principles of the language. Having no firm rules of grammar or syntax, having no power to fix the meanings of words or to create new words, or to do anything apart from the welter and flux of the national languages—and, with all this, claiming to be a reliable and precise instrument for conveying scientific thought—Interlingua strikes me as a colossal rationalization. The notion that one does not have to *learn* a language, to master its disciplines, to bow to its caprices, seems to me an utter delusion. Perhaps one of these days we shall rediscover the solid virtues of a middle-ground auxiliary language such as Esperanto.

JAMES F. RETTGER
4412 Volta Place, N.W., Washington, D.C.

For the past year I have been following with interest the spread of the use of Interlingua for summaries of papers in a growing number of journals in the medical field, and have wondered who might be promoting it among the publishers and editors—a rather ultraconservative group of individuals. It would be wonderful if the problem so succinctly restated by F. F. Cleveland [*Science* **126**, 64 (1957)] could so easily be solved; I am not so sure it can.

Since I am by no means a linguist, I have no ready-made prejudices against a synthetic language, even such a bastard one as Interlingua. I should rather say that its justification lay in whether or not it really works—and at first glance Interlingua does seem to work, just as the advertisement on the editorial page promised it would. I have no doubt that any sampling of its readability among conventionally trained scientists would achieve a satisfyingly high score, at least in the presentation of summaries or news notes. I did not get the impression from Cleveland's account of his interesting experiment that the ultimate suitability of Interlingua as a precise, universal "scientific" language had been thoroughly demonstrated in connection with the actual texts of *technical papers,* but certainly his approach is a refreshing one.

But as I read his article, the heretical suspicion kept gnawing at me that if I had never had to sweat over my high-

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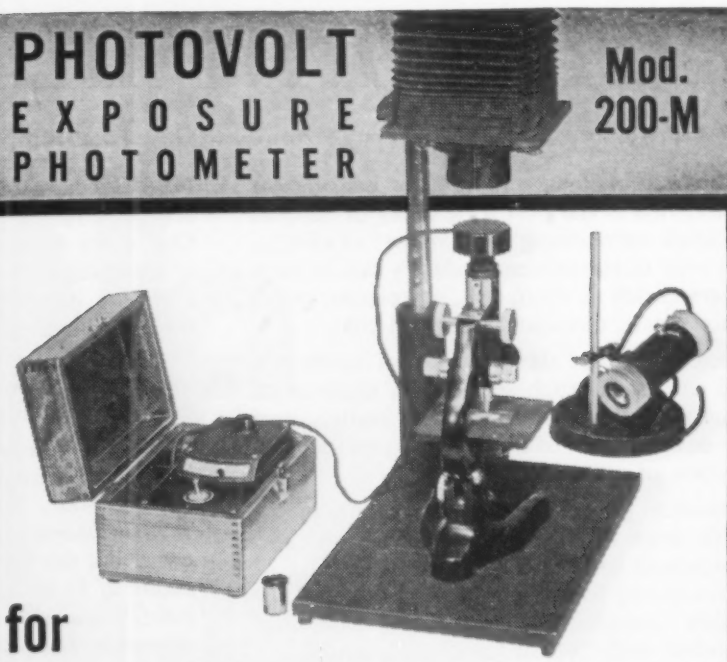

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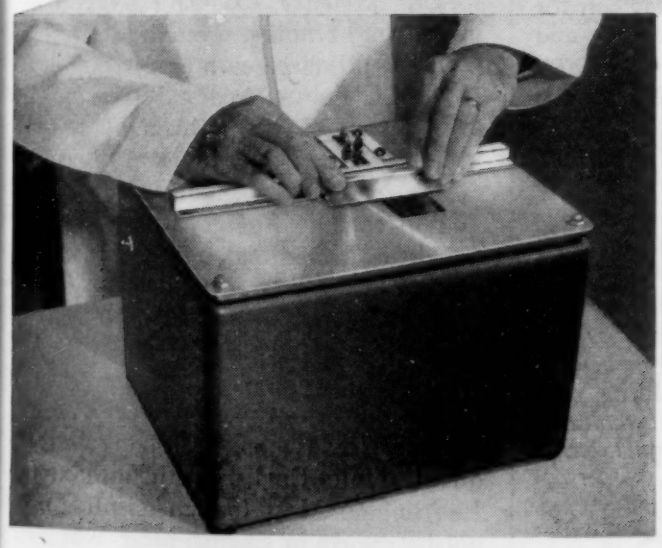

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ENVIRONMENTAL RADIOACTIVITY SURVEYS

Since we started in business, one of our important activities has been conducting site surveys for operators of nuclear reactors. These studies are undertaken prior to start-up to determine the level of "background" radioactivity in the area surrounding the reactor.

This then provides a basis for measuring any increase in radioactivity after the reactor is in operation. Environmental radioactivity studies are required. Such studies should also be made on a continuing basis not only for safety's sake but to provide "third party" legal protection against lawsuits and insurance claims.

In conducting a site survey, NSEC takes samples from the surrounding area. These may be soil, ground water, plants, animals, fish, rainwater, dust, sewage or other materials. We consider carefully the nature of the facility, the terrain, direction of air movement, and surface and ground water flow. The samples are processed and analyzed in our labs. We are then able to establish the radioactivity level, the kinds of isotopes producing it, and the possible sources of these isotopes.

NSEC has conducted more site surveys of nuclear facilities than any other company in the United States. *For information on environmental radioactivity surveys of your nuclear site, phone us at HOmestead* 2-4000 *in Pittsburgh. We can either conduct the survey for you, or train your personnel on proper procedures.*

PREVENTING BEACH POLLUTION

Recently, in the largest radioactive tracer study ever conducted in the United States, NSEC successfully traced the dispersion of sewage effluent flowing into ocean waters. Our study helped the City of Los Angeles in planning expansion of its sewage system. First we injected the isotope scandium-46 into sewage about to be released into Santa Monica Bay. This enabled us to measure the pattern of sewage diffusion and its dilution in sea water to one part in ten thousand.

Write for a copy of "Radioactive Tracer Study of Sewage Field in Santa Monica Bay" by Dr. Ralph L. Ely, Jr. (He's our Vice President and Technical Director.) Or ask about our forthcoming study for the Republic of Venezuela, in which we will investigate littoral drift, using radioactive sand, to determine the feasibility of a certain harbor location.

RADIATION SICKNESS

It's common knowledge that excessive radiation produces harmful effects in human beings, ranging from mild nausea or skin burns to cancer and death. Recent experiments under the direction of Dr. A. Edelmann, Manager of our Department of Biology and Medicine, have indicated that radiation can also produce a toxic factor which appears in the blood. Analysis of the blood of rats subjected to X-rays under varying conditions not only indicates that a toxic element is produced but that it may be transferred by injection from one animal to another.

When and if this toxic substance is identified, it may be possible to devise an antitoxin to alleviate some of the effects of atomic radiation. *Medical and pharmaceutical applications of controlled radioactivity open up entirely new means of studying existing problems. Contact Dr. Edelmann about your problem.*

DETERMINATION OF BORON IN SILICON

A major problem plaguing the electronics industry is achieving ultra-pure silicon for transistors. Current methods are slow and costly, but effective. Nevertheless, boron still remains as a damaging impurity even in minute quantities of only a few parts per billion. Ordinary chemical methods cannot detect the presence of boron in such small concentrations.

However, NSEC scientists are now perfecting a process by which the boron is transmuted into radioactive carbon-11 and subsequently measured by its radioactivity.

This new method of analysis will be helpful in the quality control of silicon during production. *Once a routine method is established it will be offered on a commercial basis. Interested? Drop us a letter.*

We'll be glad to furnish detailed information on any of these studies. And if you'd like to keep abreast of new developments in the field, just ask us to put you on the mailing list for our monthly publication "Radioactivity at Work."

Our technical staff is available for consultation on your specific requirements and will make proposals and quotations without obligation.

Nuclear Science and Engineering Corporation

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school Latin, if I had not majored in college German or had the minimum exposure to French with which to face the old-fashioned language requirements in graduate school, if I had not accidentally acquired a smattering of reading Spanish, and, most particularly, if my mother tongue were other than English, I could not have read more than a word or two here and there. I am quite sure this potential bias applies to Cleveland's entire test sample of scientific readers.

If, as has been suggested, scientific training programs should drop their language requirements, will not their future trainees have to "learn" Interlingua—less laboriously than they would learn French or German, perhaps, but learn it none the less—a language with no integral form, with a limited and makeshift vocabulary (apparently chosen simply as sops to half-a-dozen current languages), and with a basic syntax that actually requires a fair facility in English? If it should turn out that Swedish, Japanese, German, Russian, Hindi, or even English-speaking scientists require a basic facility in several languages in order to communicate precisely in Interlingua, then indeed we might have been hoaxed, and our energies might better have focused in the first place on the adoption, for international scientific use, of one of the modern languages—one in which precise communication *can* be effected and in which scientific literature can accurately be read by librarians, editors, and even laymen, as well as by scientists.

ALAN MATHER

Memorial Hospital, Wilmington, Delaware

Watson Davis's article on "Babel Resolved" [*Science* **126**, 55 (1957)] made interesting reading, even if not everybody would agree with every point of it. However, he touched only one out of four aspects of this problem.

For scientists, *babel* means difficulties (i) in reading foreign science abstracts; (ii) in reading foreign articles; (iii) in personal correspondence with foreign workers in the same field; and (iv) in oral discussions with foreigners at international conferences. International use of English has largely overcome some of these difficulties. We have, in Washington, services which translate abstracts directly into English without need for Interlingua. Most foreign scientists may not be expert in English but can at least write a decipherable letter in broken English. But at international conferences we keep meeting the Frenchman who does not understand your English question and who can answer it only in French after someone translates it for him, not to mention the American sci-

entist who feels ill at ease at a conference in Paris. Also, how many of us can read most of the foreign scientific literature easily enough to actually do so? Foreign articles and oral discussions in foreign languages are therefore our main problems.

Forrest F. Cleveland [*Science* **126**, 64 (1957)] rightly says that translation of articles is not a satisfactory solution, if it is practicable at all. Where would we find all the translators it would require? A solution will be found only if and when we scientists all write originally in one and the same chosen language, and do the writing ourselves.

I agree with Watson Davis that *if* one knows enough other languages, then one can usually *guess* the meaning of a sentence in Interlingua or Esperanto after reading it two, three, or four times. The question of readability at sight, however, is rather irrelevant. *Any* language with an international vocabulary (there are several) is more or less easy to decipher. The main difficulty is not in the reading but in the writing, the speaking, the understanding of the spoken word. The greater regularity of Esperanto over Interlingua makes Esperanto greatly preferable. The confusion created by Interlingua's so-called "natural" accentuation of syllables (whatever that means) is sufficient to make a person understand why, at conferences, Interlingua (though admitted for written abstracts) has never found oral use even as a secondary language, contrary to the situation with respect to Esperanto, which is used every year by thousands at international congresses in which is is the only congressional language.

Esperantists don't claim that texts in Esperanto would be completely understandable to persons too lazy to learn even the simplest elements of the language (though, if you try it out for yourself, you may find Esperanto just about as easy as Interlingua). But we do claim that it is some five times easier to learn it for active use than it is to learn any national language. I was able to translate *into* it, faultlessly, from the daily newspaper after 18 hours of pleasantly easy study. (Since I already knew a couple of other languages, learned in highschool, some may be a bit slower.) To learn to *read* Esperanto requires much less time.

I admit that if right now we could make Esperanto internationally a required subject for all sixth-grade school children, it would yet take many years before they would start using it generally for international communication. But at that time they would like to find abstracts of older papers published in Esperanto rather than in Interlingua.

There was a time when German was *the* international language for physics and for some other branches of science.

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SEE PAGE 550 OF THIS ISSUE

Since 1933, English has taken its place. In this world nothing lasts forever. The present position of English will last an even shorter time if no funds and no legislation are available to get high-school children interested in science, as might be achieved if instruction were given by people who, by acquiring an M.S. or Ph.D. degree in the subject they teach, had shown that they are interested themselves and have, as background, an understanding of the epoch-making progress in science that is being made, to a degree not likely on the basis of undergraduate courses alone. If it is utopian to expect this, then I keep my fingers crossed for our English-speaking descendants and hope that the next change of international language will be a switch to Esperanto rather than to German, Russian, or what else. To achieve this in time, however, the Esperanto movement needs solid support now.

F. J. BELINFANTE
Department of Physics, Purdue University, Lafayette, Indiana

Significantly, the "spread in the use of Interlingua" in scientific publications has been largely spontaneous. Many editors have felt a need for such a means of increasing the number of readers of their journals and of thus facilitating the advancement of their field of science. Upon seeing a sample of Interlingua, they have been impressed with its readability, have investigated its suitability for use in their journal, and have decided finally to use it for summaries or otherwise.

The contents of *Spectroscopia Molecular* have included not only "summaries" and "news notes" but also short technical articles and three technical monographs published in serial form before being collected into book form. Copies of the first monograph have been sold in 25 states of the United States and in 19 other countries, while the second has been sold in 15 states and in 9 other countries—despite the fact that the material was already available in the journal. It seems quite certain that this demand for the monographs, and for the quite technical issues of the journal, would not have existed unless the buyers had felt that Interlingua was a "precise, universal, and 'scientific' language."

Most persons, including scientists, will (and should) continue to have some knowledge of European languages as a part of their general educational and cultural background. The greater this knowledge the easier it will be to use Interlingua. But even if scientists must learn Interlingua from the very beginning, they will find that this requires less time than is needed to learn one of the national languages. Besides, it seems

quite improbable that any national language will approach universal usage. Much material is now published in English, but many cannot read English. For example, the recent UNESCO report [*Scientific and Technical Translating and Other Aspects of the Language Problem*, J. E. Holmstrom, Ed. (Columbia Univ. Press, New York, 1957), p. 13] says: "Nearly two-thirds of engineering literature appears in English, but more than two-thirds of the world's professional engineers cannot read English and a still larger proportion of English-reading engineers cannot read scientific literature in other languages. In other words, leaving qualitative differences aside, the greater part of what is published is inaccessible to most of those who could otherwise benefit from it."

The average scientist can probably read Interlingua at sight with 80 percent comprehension. Thus, material written in Interlingua is immediately useful to him, since much of his reading consists in scanning articles to see if they contain material of importance for his work. For articles which require 100 percent comprehension, or for writing in Interlingua, use of the dictionary and grammar will of course be necessary. [To test whether Esperanto would be equally readable and useful, the reader may compare the parallel texts in Interlingua and Esperanto in the *American Journal of Physics* [21, 471 (1953)] or in the UNESCO report (p. 200)].

To speak for myself, if a scientist who is by no means a linguist could first see a sample of Interlingua in February and begin editing and publishing a periodical the first issue of which appeared in May of the same year, despite a concurrent heavy schedule of teaching and research, it certainly cannot be too hard to learn to write in Interlingua.

The scientist is a busy person. If he has to take the time to study a new language, however simple, before it begins to be of use to him, he probably will not do it. But if there begins to appear literature of importance to him in a language he can largely comprehend at sight, he will probably scan it. And if by such scanning, and by use of the dictionary and grammar for careful reading of those articles that are of importance for his work, he is able gradually to perfect his comprehension while obtaining information that is of use to him, then it is possible that he may begin to appreciate the advantages of this common language. He may even finally begin to write and speak it in order to carry his ideas and results to a wider audience. Let us hope so. For if this were universally done, the gain to science would be substantial.

FORREST F. CLEVELAND
Department of Physics, Illinois Institute of Technology, Chicago

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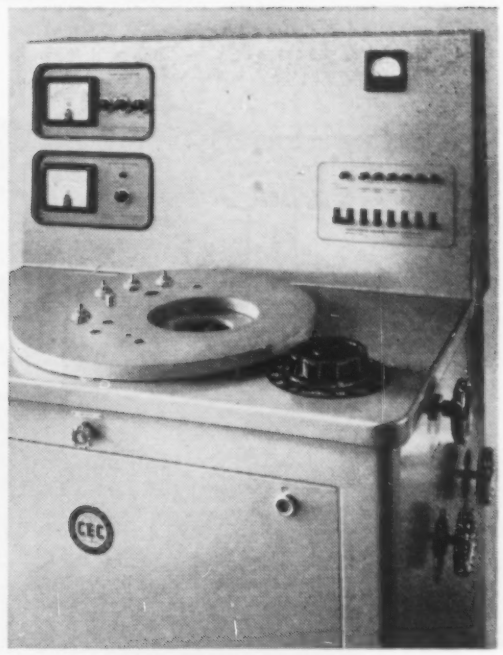

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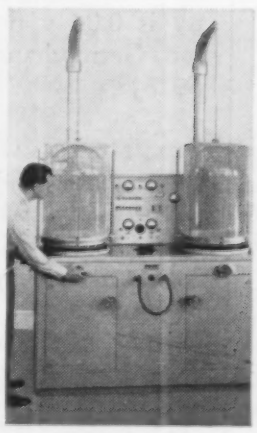

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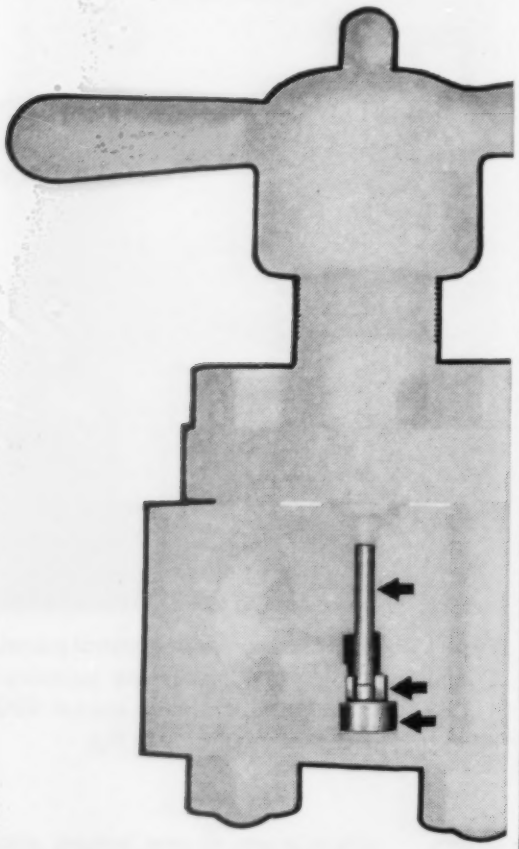

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EQUIPMENT NEWS

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. All inquiries concerning items listed should be addressed to* Science, *Room 740, 11 W. 42 St., New York 36, N.Y. Include the name(s) of the manufacturer(s) and the department number(s).*

■ CRYSTAL LATTICE MODELS of German manufacture now include feldspar, alpha quartz I, alpha quartz II, beta quartz I, and beta quartz II. Models, consisting of wooden spheres fixed and joined by metal rods, are designed on the basis of x-ray- and electron-diffraction data. Linear magnification is 2.5×10^8, so that 1 A is 25 mm. (Arthur S. LaPine & Co., Dept. S907)

■ POWER-SUPPLY REGULATION ANALYZER measures applied d-c voltage, the percentage change in applied voltage, and the root-mean-square ripple of regulated and unregulated power sources. Voltage range is 1 to 3000 v; accuracy is ±0.1 percent. Percentage regulation is measured in four ranges of sensitivity from 0.005 percent to 5 percent each side of the null position. Ripple voltage is measured in 11 ranges to 100 v r.m.s. Provision is made for oscilloscope display and for external recording. (Kepco Laboratories Inc., Dept. S917)

■ TRAVELING-WAVE OSCILLOSCOPE is designed to display transient and repetitive phenomena in the millimicrosecond region. Frequencies as high as 2000 Mcy/sec and voltage levels of 40 to 50 mv can be detected. The total size of the display is 0.4 by 0.6 in., but the extremely small size of the cathode-ray beam spot, 0.002 in., permits resolution equivalent to that of a standard 5-in. cathode-ray tube. In terms of trace widths, sensitivity is 0.06 v per trace width. (Edgerton, Germeshausen & Greer, Inc., Dept. S925)

■ DENSITY MEASURING SYSTEM consists of a probe and a power supply. The probe is coated to resist the action of liquids being observed. A standard model has a range of 0.60 to 1.45 g/cm³. Time response for a change of density of 0.01 g/cm³ is about 1 sec. Temperature range is 0° to 100°C. Output from the instrument can be used for recording density. (General Communication Co., Dept. S930)

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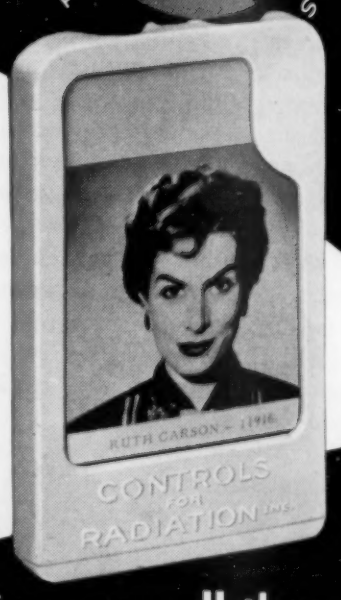

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■ SIEVE SHAKER uses a shaking pattern which involves rotation of the sieve platform in a small circular arc at the same time that it is being swayed in a vertical arc. An impact is imparted to the platform six times per revolution. Hand-operated and motorized models are available in sizes for 8- or 12-in. diameter sieves (Soiltest Inc., Dept. S932)

■ TEMPERATURE - COMPENSATING TIMER permits compensation for the influence of temperature on photographic development. The temperature change to be compensated is detected by a thermistor and is used to control the frequency of current supplied to an electric clock. Thus the clock rate is retarded or advanced as required to insure proper development. Range of compensation is ±4°F. Calibration can be accomplished for almost any film-developer combination. (Eastman Kodak Co., Dept. S934)

■ CORE TESTER provides a display of coercive force, saturation flux density, *Br* to *Bm* ratio and differential permeability, and the shape of the hysteresis loop. The tester is of the current-reset type. Characteristics are displayed 60 times each second. (Mack Electronics Division of Mack Trucks Inc., Dept. S937)

■ PROXIMITY DETECTOR is sensitive to change of position of metallic objects passing within ½ in. of the pickup. A 1/16-in. change in position is detectable. Response rate is 400 per minute. Output is nominally 5v, dc across a 5 Meg load. (Autron Engineering Inc., Dept. S938)

■ REACTOR PERIOD AND POWER LEVEL indications are provided by a combination of a logarithmic picoammeter and a reactor-period meter. Current is measured from 10^{-13} to 10^{-6} amp; positive and negative reactor period from 3 to 30 sec. After warm-up, drift of the log circuit is within 0.05 decade in 24 hours. The period meter has 5-sec recovery time from overload and adjustable response time over a 10-to-1 range. (Keithley Instruments Inc., Dept. S939)

■ HEIGHT GAGE uses a glass scale and glass vernier scales to provide readability to 1 mil. Height adjustment knobs are located in the base of the device to avoid any tilting tendency on adjustment. Available sizes range from 18 to 84 in. (George Scherr Co., Inc., Dept. S940)

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